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THE BLIND CHILD AND HIS PARENTS
CONGENITAL VISUAL DEFECT AND THE REPERCUSSION OF FAMILY ATTITUDES ON THE EARLY DEVELOPMENT OF THE CHILD*

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INTRODUCTION

It is evident that the mere existence of a handicapped child invariably alters the balance of the family. While this situation is held by many writers to be responsible for any evident upsetting of the balance, from the separation of the parents to severe psychiatric pathology of one of its members, an alternative view is that the family reaction depends rather on "pre-existing psychological conditions," inasmuch as the handicap would seem to permit the expression of feelings which, in the normal course of events, would have been less intense or better controlled (Coughlin, 1941). Furthermore, for many of those in charge of guidance or educational services, it is always the inadequate attitude of the family which is blamed as the origin of vicissitudes in the child's development and his failure to adapt to his handicap.

On looking into the literature concerning family reactions to the handicap of a child, one constantly meets a number of stereotypes, irrespective of the handicap in question: parental depression, especially in the mother; wounded narcissism; anxiety and guilt at the time of discovery of the handicap; later, compensatory attitudes of rejection or of overprotection, etc. In practice, going beyond these similarities, one is struck by the disparity of these family reactions and by the frequent disproportion between their possible intensity and the real limitations which the handicap implies. It is from this dual viewpoint that one may grasp, on the one hand, the symbolic value of the handicap and, on the other, the possible role of pathological elements in the parental structure which already existed prior to the new situation created by the handicapped child.

It is not our intention to attempt a comparative study of the respective parts played by blindness and by other handicaps in originating an early disturbance of the child-family relationship. In fact, it seems clear to us that the early or congenital visual defect of the child is indisputably specific:

> on the level of reality, blindness is not equivalent to any other handicap; even granted an ideal mother-child relationship and the best possible education, the earliest development of the blind child will follow a very different evolution from that of

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*This is an English language version of the paper "Attitudes Familiales et Deficit Visuel Congenital," originally published in the journal *Interpretation*, Vol. 5, No. 2-3 (April-September 1971), pp. 157-186.

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the sighted child, and all his later adaptation, both educational and socioprofessional, will run up against great difficulties;

on the symbolic level, blindness is in a special position owing to the fact that in every individual it evokes very primitive fantasies relating immediately to sexuality and castration. It is enough to recall the position of blindness in mythology as being a condign divine punishment for incest, reserved strictly for men. The well-known ambivalence of these fantasies, which bestow simultaneously on the blind person both total impotence and a magic omnipotence, could not be better illustrated than by the image of the adolescent albino in Fellini's *Satyricon*, blind and impotent, but hermaphrodite and a god. In the parents of a child born with a visual defect, this often provokes phobic reactions, which in turn influence the child's development through his object relations and his learning processes. In fact, the absence of sight rules out any possible grasp of the world at a distance. This grasp can come about only through the mediation of "tactile seeing" and will thus depend on "what is given to touch," with all the imaginable limitations due to prohibitions against eroticized touch.

This immediate phobic *reaction* can be overcome, either spontaneously, or more especially with the aid of guidance. However, when a phobic *structure* exists in one of the parents, and particularly in the mother, prior to the birth of the blind child, an almost inevitable arrest of development or the psychosis of the child is to be expected.

That a blind person can reach a normal or even a superior level of development and integration is a truth underlined by many writers, and on this is based the claim that blindness as such is not a sufficient condition for the hindrance of intelligence in the widest sense (Hatwell, 1966). However, the proportion of backwardness or of psychosis is distinctly higher among children born blind than among sighted children, which frequently gives rise to the diagnosis of "multihandicap" even in the absence of any other associated physical defect. This notion, which is very widely turned to account in countries where the appropriate educational and therapeutic possibilities remain unreliable, certainly deserves to be very widely criticized.

On the other hand, in countries where more systematic studies have been carried out, the notion has gradually evolved that the retarded or deviant development of blind children depends more on early education than on their blindness as such. Thus, from a survey carried out over a period of five years on a group of nearly 300 children born blind (Norris, 1956) arrived at the conclusion that the development of the blind child who has no other major physical handicap may show a regular pattern of progress, at the end of which he will reach, at school age, the same level as that of sighted children of his age, provided that the educational situation has been "favorable."

This writer emphasizes the extreme diversity of the levels of achievement of blind children, the importance of fluctuations in the scores gained by a child in the course of studies over a period of time--fluctuations which are always linked to variation in the factors of the child's environment and concludes that what creates problems is not so much blindness as the adult's incapacity to know what he may *expect* from a blind child and how to encourage his optimal development.

We owe the most remarkable studies of the congenitally blind child to psychoanalysts. The descriptions and interpretations to which we shall refer are the outcome of their direct observation of children carried out within the framework of guidance begun as early as possible after the discovery of blindness, and of the treatment of certain cases referred to them at

a later stage with records suggesting retardation or psychosis (Burlingham, 1961, 1964, 1965; Fraiberg and Freedman, 1964; Fraiberg et al., 1966; Fraiberg, 1968; Omwake and Solnit, 1961; Burlingham and Goldberger, 1968).

These studies allot a position of primary importance to the environment in general and to the family in particular. First, guidance as conceived by these writers represents a therapy for the parents, to the extent to which it is not confined to outlining suitable behavior towards the child and to giving educational advice concerning his training, but inasmuch as it enables the initial shock of the discovery of the handicap to be toned down and permits them to understand the meaning of the phases of regression which will inevitably mark the child's path of development, even if this is a favorable one. Second, the therapy of very disturbed children also consists of taking in hand the whole family, even in psychoanalytic treatment of one of its members.

In France there is no systematic guidance service or any possibility of early specialized education for the visually handicapped, and it is often from the age of five or six onwards, and sometimes very late, that we are asked to assess these children with a view to their schooling or institutional care. However, at our instigation we have for several years been able to see younger children, chiefly in an ophthalmological capacity, and to trace the development of a number of them. Our observations, compared with those of writers who have been able to study blind children from birth or during the first months of life in the framework of intensive guidance, enable us to consider the disturbances in the child's development and their relation to the family attitude not only phenomenologically, but also dynamically; and to specify what in these disturbances and attitudes can be influenced toward "normality."

SELECTED DATA FROM THE LITERATURE

We shall attempt to summarize the views of the writers concerning, first, the optimal development of the blind child under guidance, by making an artificial division into various "sectors" which we shall again make use of in the analysis of our own data, followed by the picture of delay or "deviation" in this development.

During the first year, and especially the first eight months, there may be no quantitative retardation (by the Gesell tests, for example) of the postural development of the blind baby: the holding up of the head, the movements of the body turning over in the cradle, the seated position, the position standing with support--all these may be observed at the same ages as in the sighted child. This continues to be true of the selective smile at sound or contact (the mother's voice, or contact with the mother), the first vocalizations, and the acquisition of the first words.

Clear differences become apparent beginning in the last quarter of the first year and during the whole of the second year: no crawling on all fours; considerable backwardness in walking; a halt in acquiring new words; continuation of a great selectivity of affects, with extreme dependence on the mother or on a small number of special members of the household. These difficulties may be overcome later, chiefly from the third year onwards, when the child is able to acquire normal autonmy of movement and speech.

It is in the *sensorimotor* field, the field of exploring and manipulating objects, that distinct differences are observed very early. During the greater part of the first year, the blind child has no spontaneous tendency to move his hands and arms. He does not hold out his arms to be picked up. Burlingham (1961) correctly observes that the blind child in the cradle moves his feet and legs much more than his hands and arms, which for a long time retain the newborn position, with arms bent and hands at shoulder level. The hands are rarely brought to the midline and the child does not play with his fingers.

The reactions of orientation to noise, which appear about the second month in the sighted child, are

observed only towards the seventh month in the blind child.

The voluntary grasping of an object (which appears spontaneously at approximately five to six months of age in the sighted child) begins in the blind child at about seven months, for an object which has just been handled and then taken away from the child, and at about one year for an object located by purely auditory clues. The concept of object permanence, in Piaget's sense, takes root only very late and remains weak for a long time. In this area the blind child shows a developmental delay of at least a year, which bears witness to the primary role of vision in the constitution of mental representation. This notion can be acquired by the blind child only after a prolonged phase of training in which tactile manipulation plays an essential part, as purely auditory information is not enough to give substance to the object unless it has been handled simultaneously, or very recently. Thus, for a long time there is no active seeking for the object lost, as if it existed only while in direct contact with the child.

The development of speech undergoes a very special course of development starting from actual verbalization during the second year. Whereas the sighted child rapidly enlarges his vocabulary, the blind child does not increase his stock of words and may even forget words already learned. Only in the third year, and especially when he is able to move about autonomously and enter into contact with more and more objects, does his language really become richer (Fraiberg, 1968). But one may also note the acquisition and use of a great number of words which are devoid of meaning for the child and are a mere imitation of the speech of sighted persons.

Burlingham (1961) considers that the oral pleasure derived from the first babbling plays a greater role and lasts longer in the blind baby than in the sighted one. Before being used for communication, words are toys, and talking is an activity which is an end in itself. The excessive prolongation of this mechanism may lead to the echoed speech, or verbalism of the blind. Here, too, one may expect the adequacy of the child's speech as a means of communication to depend on the adequacy of his environment.

In the foregoing outline we have, as much as possible, limited the consideration to motor and cognitive development. Indeed, a fundamental notion which is much stressed by these authors is that this development demands a much more intensive training than in the case of the sighted child; that this training is not spontaneous but must be induced by the adult and, above all, that it can be meaningful only in a context of satisfactory libidinal object relations. Here lies all the importance of the family attitude (which for the sake of simplicity is often limited to the mother's attitude) and of the quality of the mother-child relationship.

For the first few weeks or months of his life the blind child is in fact very quiet and may remain passively, for a dangerously long period, in what S. Fraiberg (1968) calls "a void" which can be filled only by what is given from outside. It is most important that from birth the child should be held in the arms, played with, and placed at the center of family activities during his waking hours; but it is still more important that the stimuli given to him should be a source of pleasure to their originators as well as to him. Only through shared pleasure can a "dialogue," in Spitz' sense, be set up between the baby and his human environment.

This is indeed not peculiar to the blind child and is valid for all children, but--and this is the first stumbling block--the blind child who needs more stimulation than a sighted baby, both quantitatively and qualitatively, is likely to be to a great extent deprived of this, as on the one hand he asks for less, which is the first expression of his passivity, and on the other the mother may remain withdrawn from the child owing to her depression. It is at this point that early guidance finds its full justification and usefulness if it succeeds in diminishing this initial maternal reaction and in encouraging mutual pleasure through interaction.

Libidinal object relations may, therefore, be established normally during the first year and the child may show a selective attachment to his mother or to the people around him, whom he distinguishes from strangers by the sounds of their voices, by the way they hold him and, later, by exploring their faces. Differences are noticed very early, however. The smile is less frequent in the case of the blind child and is less distinct, as if deadened; it arises only from interaction with another person and is not evoked by inanimate objects. During the second year open displays of affection remain induced responses and the child behaves as if he cannot himself be the initiator of a relationship.

This lack of initiative is linked with a defect in the gradual gain in independence from the mother. The role of sight is here again a determining factor in the process of mental representation and internalization of the libidinal object. The same delay is seen in the realization of the concept of the libidinal object constancy as for the object permanence. Hence, the separation anxiety shows particular intensity and continues well beyond the end of the second year. The blind child seems to be reduced to a state of helplessness and panic as soon as he loses contact with his mother, and may react to this loss by a global regression in all his acquisitions. The reaction to anxiety and frustration is very characteristic in the blind child. All writers have been struck by the fact that he reacts by withdrawal, regression, immobility, and autoaggression; that energy is discharged through his axial rather than his peripheral musculature; and that there is no spontaneous tendency towards a motor discharge directed against an external object. The prolonged dependence on the mother, which entails on her part an increased dependence on the child, and the weak nature of acquisitions forever challenged by unforeseeable emotional shocks, make the child's second year a difficult and trying period. Concrete circumstances (the child's being put into hospital, ophthalmic treatment, the illness or death of a parent, etc.) may give rise to real crises which are difficult to overcome (Colonna, 1968). Many writers, in particular Parmelee et al. (1958), have observed that even in the best conditions of guidance mothers who have quite got over the initial shock of the discovery of the child's blindness may later decompensate, not knowing how to control and master this regressive anxiety.

The service of guidance and early special education (such as some "Sunshine Houses") can help considerably in coping with this critical period by widening the child's field of cathexes, by developing his motor initiative and his mastery of an environment which offers both richness and security, and especially by helping the mother to understand her child's needs and to meet them without excessive anxiety or guilt.

It is between the ages of three and five that the child is able to acquire progressively greater self-control and improved emotional stability. At the age of five or six he may attain qualities of autonomy, control, and curiosity which render him fit to begin schooling, as such, with the appropriate technical facilities.

Inasmuch as this result is strongly dependent on previous training which involves the active intervention of the mother at every stage, the difficulties and hazards of this learning process must be stressed. Winnicott defines the *good mother* as one who "must be capable of adapting actively to the child's needs." In the case of the blind child, these needs are at once unexpressed (initial passivity) and very complex; the necessity to compensate for the absence of sight by awakening all the other channels of sensation, tactile, auditory, kinaesthetic, etc. (but the child has no spontaneous tendency towards such compensation), and the necessity of existing in the other's fantasy in spite of the difficulties of identification created by blindness.

Learning by itself, or "overstimulation," might suggest that the blind child should in every way and at the same ages behave "like" a sighted child. In fact, what is necessary is to create and maintain gratifying conditions of exploration

(both for the mother and for the child) which may in turn facilitate motility, intentionality of movement, dialogue and so on, not by a simple imitation or "veneer" of the sighted child's behavior, but by means suited to the blind child who is accepted as being different and as having a special pattern of development.

Burlingham (1965) rightly insists that learning and play should merge and that this is one of the things which should be taught to mothers. She attaches a high value to bodily games: the mother's playing with the child's body and the blind child's exploring his own body and his mother's body, which is still more necessary to him than to the sighted child.

In the opinion of this author the mother's body retains its function of a "toy" well beyond early infancy and certainly until the age of three. She attributes to a scarcity or absence of these early bodily games not only the lack of libidinal cathexis in the child's own body (which could, we believe, be the source of disturbances in the body scheme so often observed later) but also the blindisms (rhythmic rocking movements and repetitive movements of the body or the hands) so common among blind people that this name has been given to them, even though they may also be seen in autistic sighted children.

These blindisms are also attributed by the same writer to the restriction of movement caused by blindness to the extent to which it deprives the child of any possibility of controlling the consequences of his actions, and which is maintained by the household because of the real or supposed dangers which they wish to spare him in the external world. In her view they have the double function of autoerotic activity and of discharging energy which cannot be otherwise discharged.

The choice of "toys," vehicles of the learning process, should be decided upon in accordance with the blind child's own needs (Burlingham, 1965); many traditional toys (small scale models, for example) have no meaning for him, although handling the real adult objects may interest him (saucepans, car, light switch, etc.); certain children's games hold no interest unless they are played differently (for example, building a tower with blocks becomes a game only if the child is first allowed to knock down the tower built by somebody else) and certain activities take on a special importance (games with doors, for example). The ingenuity and tolerance of the family may be measured by the diversity and adequacy of the play activities supplied or at least not forbidden to him in his family environment.

It seems that the completion of the blind child's early development requires the recognition and verbalization of blindness by the child, and the most favorable time is at about four or five years of age (Burlingham, 1961; Cratty et al., 1968), but often later (Deutsch, 1940). The other's ability to see is experienced by the child as a magic power: the sighted person can "feel" and "know" without touching; one cannot hide from him, whereas he can disappear or reappear as he pleases, etc. The magic omnipotence of the sighted adult for the blind child finds support in reality which experience tends to strengthen instead of progressively controlling. It is clear that the recognition of the blind/sighted difference is superimposed on that of the difference between the sexes. The latter may be hidden or distorted to an equally great extent by the absence of sight, and especially by the attitude of sighted adults, the mother in particular and then the teachers. They very often feel that learning or information at this level is useless, or impossible, even forbidden, as the blind person can be conceived only as castrated or hermaphrodite, but not as a sexually differentiated being. Here we must stress the absence of reported data, the rarity of experiments on sexual information or education of the blind, and the very belated nature of this education when it is finally planned (Van't Hooft and Heslinga, 1968; Wright, 1968).

On the other hand, we do find in the available literature cases of congenitally blind children whose development, far from being optimal, is very delayed or "deviant," but whose disturbances can be totally or partly reversible at the cost

of intensive care of the child and of his family.

Fraiberg (1968) points out the uniformity of the clinical pictures, and the descriptions of other authors (Keeler, 1958; Parmelee, 1955; Parmelee et al., 1958) correspond to hers. The children she has studied show the same symptoms irrespective of age, and their behavior at ten years old may be identical to that at three years old, with the exception of progress made in the field of locomotion. This would seem to be an arrest of the ego development occurring in the second year, which resembles psychosis but differs from the cases of autism observed in the sighted child and coincides rather with the classic case of Spitz' *abandonism* where the child spends most of his time lying in bed, in an armchair, or on the floor, chewing an object with an absent-minded air. Objects or toys hold no other interest than to be put into the mouth, which remains the primary organ of perception. The hand has no autonomy of its own and is not used for exploration or manipulation. It is the *blind hand*, incapable of a voluntary coordinated movement, which seems to be solely at the service of the mouth yet unable to be used for voluntary feeding.

Contact with human beings is of a very primitive kind, symbiotic fusion, or clinging and biting. The mother may be the preferred object, but sometimes the mother is in no way distinguished from the environment and this behavior is generalized. Also to be noticed in these children are the ceaseless rocking movements of the head or body, or rhythmic flapping of the hands and arms. Speech is essentially echoed, with repetitive use of words, sounds, or phrases which the child has heard. He refers to himself in the third person and speech is not used for communication.

Most of the authors who have analyzed these cases emphasize the considerable disturbances in the family which the blindness has brought about; severe and long-lasting depression and guilt in the mother and her failure to establish "emotional contact" with the child in the course of the first few months (Keeler, 1958). Fraiberg (1968), Burlingham and Goldberger (1968) stress the fact that these patterns can be reversed if they are treated (both mother and child) early enough. The later the educative therapy begins, the more incomplete and hazardous will be the improvement.

But here, too, one may wonder whether the limits of this improvement are not those of the environment, therapeutist included. In the case of "Peter," described at length by Fraiberg and Freedman (1964), the treatment was abandoned at the advent of puberty, it being considered that the results attained could not be surpassed. This is oddly reminiscent of the case of Itard's wild child.

SUMMARY OF THE AUTHOR'S OWN DATA

Over the last eight years we have examined about fifty children, either completely blind or with very poor sight (legal blindness), under six years old, and chiefly at the National Ophthalmological Centre of the Quinze-Vingts. We have been able to follow the progress of a number of them insofar as their parents asked to see us again or accepted our suggestion to follow the development of their child.

In the case of multiple examinations long and repeated interviews with the parents enabled them to become conscious to some extent of their attitude towards the child, and even to alter it.

During these examinations we very frequently came across some of the kinds of behavior just described, but if we were impressed by the magnitude of the disturbances both of the child and of the parents, the diversity of the pictures seemed to us as striking as their gravity. This brought home to us the need for a method of examination whereby the quantified evaluation of a level of development would take on meaning only in the context of observation of the child and the parents in their reciprocal relationship. For every case and at each consultation the examination lasted for several hours and was carried out by two different people. It consisted on the one hand of the application of a scale

of development, and on the other of an interview with the parents (most often the mother) and observation of the child in their presence.

The test used was the scale of social development of Maxfield-Bucholz (1957), (Leger and Lairy, 1965), which is the only test standardized on a population of young blind children. Its internal organization has been rearranged and complemented with items from Brunet-Lezine for children less than one year old, and from Hayes-Binet for older children.*

The Maxfield-Bucholz scale of social maturity is a questionnaire which asks of the person questioned--usually the mother--a detailed description of the child. Its chief interest lies in the fact that this description rapidly transcends the boundaries of the questions asked and develops into a free discussion, in which ignorance, errors of judgment, feelings expressed, and emotional coloring permit an understanding of the way the mother sees her child; the mother-child relationship influences the protocol in two ways. This relationship determines the child's level of social functioning and conditions its presentation in the mother's account; but compared to reality the mother's account constitutes a distortion which must be circumvented and assessed if the inquiry is not to be meaningless. Observation remains the only means of finding out the way in which the child does or does not do certain things, his attitudes toward objects and the environment, and his interactions with adults.

The criticisms which may justly be made of these tests spring from the fact that they are adaptations of tests for sighted children, and that they assess the behavior of blind children from the point of view of those with sight and in relation to them. The disguising of certain items, adaptation of performances calling upon sight, to performances calling upon the sense of touch or hearing, should not obscure this point, even if standardization on a population of blind children specifically involves blindness in the classification.

The original Maxfield-Bucholz scale is comprised of 85 items divided into six age groups, from one to six years, and these items are again divided into seven categories: general autonomy, ability to dress without help, communication, socialization, locomotion, activity. The distribution of the different categories in each age group is rather uneven.

The reorganization of this scale results in the grouping together of the scale's original items under five headings completed by items taken from the Brunet-Lezine or the Hayes-Binet tests. The five sectors of behavior are thus distinguished: posture, sensory-motor, sociability, speech, and autonomy.

Under the heading Posture (whose items only cover the first three years), only the postural *abilities* of the child are tested (ability to master the seated and standing positions, and later walking) but not their *efficiency*, which depends on learning and on what is allowed by the mother. These are assembled under the heading "Autonomy."

The Sensory-Motor sector tests in turn the motor aspect of grasping; interest in sounds, objects, and the environment; activity directed toward objects; the capacity of attention and of fixation on a given action; play activities with sounds and words and later with objects and people.

The sector entitled Sociability consists of items testing, first of all, sensitivity to human contacts, reaction to the voice, affective displays expressing the need for contact, exploration by the child of his own body and the beginning of object relations, and the distinguishing of familiar

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*These modifications have been elaborated upon by E. M. Leger, to whom we also owe a great many sets of psychological reports serving as a basis for this work.

and unfamiliar voices; later, the modalities of exchange and the internalization of prohibitions; later still, verbal knowledge of the parts of the body, the ability to cooperate and to adapt to day-to-day surroundings; finally adaptation to a wider collective existence, consciousness of self and cooperation with other children, adaptation to the group and the ability to respect its rules. Under this heading we have added a further item for the second year, measuring the ability to surpass the first oral stage by accepting solid food, and another for the third year testing the faculty of sphincter control; these two activities seem to us to assess a type of relational modality rather than the acquisition of autonomy.

Under the heading Speech we have grouped items testing solely communication with the help of ordered sounds. Verbal games, songs learned by heart, and counting rhymes have been placed under the heading Sensory-Motor.

Finally, the Autonomy sector comprises items expressing the child's ability to do things "by himself." This sector assembles the things which stand out most clearly in what is allowed, encouraged, or forbidden by the mother. This becomes evident first of all with regard to locomotion: moving about indoors and outdoors, awareness of obstacles and ability to avoid them, assessment of distances, etc.; but it is relevant to all daily activities, such as feeding, dressing, care of the body, cleanliness, etc. As for sphincter control, we have considered it important to dissociate the ability to exercise this control (measured in the Sociability sector) from the putting into practice of this ability, as the latter depends on the attitude of the mother. It may appear arbitrary that we have compiled this sector separately from that of Sociability. In fact, they test two fields which are distinct and which often are not parallel.

The results obtained from this scale lead us to the schematic description of four groups according to the overall level, but especially according to the elective nature of the disturbances in one or another of the sectors of development, and the qualitative differences between these disturbances which cannot be adequately rendered by quantitative assessment.

Group I. This group is characterized by an overall quotient near or equal to normal, with relatively homogeneous scatter in the five sectors of behavior studied. It comprises about one-third of our population and can be considered as the "normal" group. Study of the family environment shows that after a depressive phase, usually short, the child has been satisfactorily accepted and that the educational attitude has been on the whole neither limiting nor rejecting. Much more frequently than for children in the following groups, one sees siblings born after the blind child. The fact that the parents have been able to plan or to accept to have another child in itself bears witness to the family attitude. The younger child by his very existence will have a normalizing role on various counts. Being the child to "heal" the parents' narcissistic wound, he makes possible the positive cathexis of the blind child's progress, and by means of the games he shares with him he also has a favorable influence on his learning and the development of his relationships.

It should be noted that less than half the children in this group are wholly blind, and that the remainder have some useful remaining vision (legal blindness). It is certain that this weak residual sight, when it exists, can facilitate the child's early development; it allows the parents to ignore the blindness for a longer time or to valorize the remaining sight, and in this case it leads them to encourage him to use existing sight to best advantage and to develop visual-manual coordination. Later one sees in these children a good use of remaining sight in exploration or orientation.

Schooling for children in this group is taken for granted by their parents, and its variety depends on concrete factors: the degree of

sensory deficit, the geographical situation of the parents, etc. The child is even sometimes put into a kindergarten with sighted children, either spontaneously or at our suggestion.

Other types of profiles, to be found in nearly 40 percent of our population, are distinguished not so much by a mediocre overall social quotient (the average being around 75) as by the extremely wide scatter of performances, with certain sectors showing normal or superior scores, whereas others show extremely low scores. Several forms of dissimilarity may be observed, but two extremes seem to stand out in relation to the parental attitude, according to whether the failures reflects defective learning only or a disturbance of the object relations.

Group II. The second group is characterized by normal postural abilities, and especially by a normal or superior level of speech for the child's age. By contrast, performances in the Autonomy, Sensory-Motor, and Sociability sectors are mediocre and the scores under these three headings barely reach the level of approximately half the child's real age.

What is most striking in the field of behavior is the child's extreme passivity--a passivity maintained or even encouraged by the overprotective attitude of the mother, who does not encourage him to do things by himself, but takes over all daily activities from him. This state of infantile dependence also finds expression in other spheres: delay in accepting solid food, delay in acquiring habits of cleanliness (sometimes very late bed-wetting), etc. However, apart from blindisms and the usual manifestations of separation anxiety, we are dealing here with genuine delay--behavior which would be normal for a younger child--rather than with really pathological behavior.

The quality of speech should be emphasized. Indeed, the children in this group display considerable verbal richness, using language both as a means of communication and as a game. It is with these children that one often finds long periods, just before falling asleep, when they talk to themselves or to a favorite object in a way which reproduces in its terms or its rhythms dialogue with an adult. These episodes, during which the child usually seems very happy, may even precede true verbalization and testify that genuine preverbal dialogue has already been established between the child and his mother. And indeed, after the first depression, the mother waits for and experiences her child's learning to talk as a reassurance that she will be able to understand his needs and communicate with him. But these mothers very much underestimate the child's real capabilities in everything concerning his activity; they are very limiting, and spare him experiences which they fear may be traumatic. When there is some remaining vision, the child is not encouraged to make use of it for exploration, and later he behaves like those who are wholly blind with regard to orientation, locomotion, location of obstacles, etc.

It is interesting to note that there are a number of premature babies in this group. It seems that prematurity as such may play a decisive role in determining the mother's attitude. On the one hand, a very small and delicate baby handed over to the mother at a late stage and requiring special precautions in rearing during the first few months induces and justifies her anxiety and overprotection; at the same time, the real danger of the possibility of the baby's dying may annul unconscious wishes for the child's death so often observed in the mothers of full-term blind children, especially those of the following group.

These nonrejecting, "too good" mothers often become aware of their attitude in the course of the interview, and of their wish for the child to remain a small baby, easier to protect. They are quick to express their regret at being totally lacking in information hitherto, and respond readily to guidance. Usually they greet with delighted astonishment the demonstration that their child's capabilities exceed their own assessment. They willingly accept educational advice and the periodic interviews; they sometimes

even ask for them. During successive examinations of these children we have been able to measure the consequences of the change in the mother's attitude. Spectacular progress may be observed very swiftly in a few weeks or months, which has a bearing in particular on everything related to the Autonomy sector, but which can also raise the overall quotient by 15 to 20 points. This giving of autonomy to the blind child who has a good speech level will facilitate and hasten his starting school, which the mother would instinctively tend to postpone to a dangerous extent. We think in fact that disorders due to this type of parental overprotection are the most easily reversible in the preschool period. If we refer back to our earlier studies of the visually deficient child of school age, brought up without guidance (Lairy et al., 1962), we see that disorders of motor and emotional control, cognitive disharmony, and lack of eagerness to learn are frequent; the later that schooling begins the more serious they are and which then necessitate intensive education, reeducation, or even psychotherapy.

Group III. The other extreme form of disharmonious scatter is marked by normal postural development (always taking into account the characteristics of our test) and by a high score in the field of autonomy, sometimes above the normal. Yet, in the Sociability and Language sectors the scores obtained do not reach half the child's real age; the greatest failure is found in the sensory-motor field, where, in general, successes do not exceed nine months according to Brunet-Lezine and the first year on the Maxfield-Bucholz scale. Observation of the child makes it abundantly clear that these failures do not indicate a mere delay in development, but are the expression of very pathological behavior as much in exploration and learning as in relationships. With regard to grasping and manipulation of objects one may note that, in certain cases, the object is used only for aggressive outbursts, throwing, hitting, etc.; or with certain familiar objects, for delicate and complicated manipulations, stereotyped and repeated indefinitely. In other cases there is a definite refusal to hold and manipulate, or even a withdrawal by the child as soon as he comes into contact with the object, as if this contact were painful. Where food is concerned, the mother reports not only refusal of solid food but vomiting at contact with such food. Here one may justifiably talk of touching and feeding phobias. To these phobic symptoms may be added displays of terror at any unfamiliar noise.

On observation one is often struck by the child's appearance; the sartorial affectation of which he is the object, and sometimes the clash between the perfection of his clothes and the socioeconomic level of the parents immediately give the impression of a doll-child, a child-object. This child may remain clinging to his mother, huddled up against her in a symbiotic attitude, his immobility broken only by blindisms or the ceaseless movements of pressing against the eyeballs with a finger or the whole hand, and showing terror if he is touched or spoken to. He remains silent or tirelessly repeats phrases overheard, which have no connection with the immediate situation except that they seem to be intended to distract the mother's attention.

Study of their speech sometimes reveals complete mutism in the youngest children and, later, echoed speech as classically described: the vocabulary seems to be rich, and certain children are able to reproduce whole sentences which have just been spoken to them in the same tone and sometimes even in a similar voice; they may answer a question by repeating the question asked; they refer to themselves by their first name or in the third person, and they do not distinguish themselves from the person who is speaking to them or whom they are addressing. While they display an astonishing memory for words and occasionally a great interest in music, speech is not used or is used very defectively to express needs or to communicate.

The mothers of these children are very typical: they have all gone through a long depressive period on discovery of the child's sensory defect, compensated by an apparently strong attitude of attempt to overcome this. They have "decided" to

forget the sensory defect and to bring up the child "like any other," and in this way have encouraged a certain number of activities: walking, climbing, riding a bicycle, etc. In fact, during the interview it becomes clear that this depressive phase has not been left behind, that the wish for the child's death continues and that the mother is restructuring herself at the price of a negation of the defect, or of the child himself. Some mothers find it an unendurable ordeal to occupy themselves in a series of daily tasks for the child (feeding, bathing, etc.) and leave these to the care of other people--grandmother, domestic help, etc. They do not play with the child, who is often left for hours at a time with the radio or records; they pride themselves on his musical knowledge without seeming to be affected by the total absence of any possibility of dialogue. The rationalization of this attitude may be compulsive professional or housewifely activity, indispensable to their own balance. Sometimes refuge is taken in magical beliefs and the child is taken to healers or on yearly pilgrimages. All cathexis in the child is suspended while a miracle is awaited.

One is faced with a phobic structure fairly well compensated before the birth of the handicapped child, even if certain symptoms had appeared (feeding phobias, dirt phobias, etc.), and for which the upbringing of elder children would have posed no major problem. However, the possibility of having another child is always rejected in this context, even if there is no genetic reason to justify the fear of a repetition of the handicap.

These mothers are not very responsive to guidance. Interviews are difficult and are felt to be a trial and judgment to the extent that they arouse their guilt and question their defense system. They show an immediate need for individual treatment, but this treatment is always refused if the problem is raised during the interview. They ask for nothing, neither help for themselves nor educational advice for the child; if they ask for anything it is of the order of a miracle, or to place the child in an institution. In a few cases of repeated examinations we found that when new acquisitions had been made by the child they remained incomplete, or were even obtained at the price of regression in another sector. So our intervention on the mother could remove a prohibition in one sphere, but to all appearances left intact or even strengthened the mechanisms responsible for the child's retardation and its permanence.

Thus the child seems to be trapped in the maternal falsehood which consists of her apprent wish that he should be "like a sighted child" and her prohibition of his existence as a blind child. In his state of total dependence he appears to express by his phobic behavior both a response to his mother's phobia and the fear of losing his mother if he transgresses her prohibition.

These cases come close to those described by Fraiberg as *ego deviations*. It is doubtless possible to carry out therapy for the mother only from the moment of totally taking over the child--as in the case of Peter, to which we have already referred. We should recall, in this famous example, that Peter's mother embarked upon her own analysis only many months after the beginning of his reeducation in a psychoanalytic context--reeducation in which she had to participate and in the course of which she was able gradually to become aware of her own problems.

In our experience, in the absence of such possibilities most of these children are condemned to being placed sooner or later in a mental hospital. If they reach a special school, their level of acquisition remains very low and their noncathected learning remains, as it were, "external" to them and always fragmentary.

<u>Group IV</u>. The last type has a very low overall level of development, the social quotient according to our scale not exceeding 40, and a fairly homogeneous scatter for the scores obtained under all headings. It is certain that among these children are found genuine multihandicaps due to the association of blindness with an early encephalopathy. It may also be noted that certain children showing signs of deafness

associated with their blindness may come into this group, at least for as long as the deafness is not disclosed, thereby demonstrating the importance of combined sensory deprivations. But if these cases are excluded, a certain number are found for whom only a severe affective deprivation can explain the picture, identical in all respects to that of marasmus described by Spitz. In this picture of very widespread disturbance, blindness figures as an epiphenomenon. The marked delay in the postural sector should be emphasized. This has rarely been noted in the literature relating to blind children and in our population it has only been observed in this context. It may become apparent from the earliest months: general hypotonia, especially of the axial musculature; considerable delay in holding up the head and in the acquisition of the seated and the standing positions, even with support. These children also show great frailty and an extreme susceptibility to even trivial infections (rhinopharyngitis, otitis, etc.).

These cases of severe retardation through affective deprivation are relatively scarce in our population.* It is customary for them to be considered by pediatricians as "neurological" and ranked as multiply handicapped with associated brain damage. The prognosis is all the more serious in that this label deprives the parents of all hope at the same time as it soothes guilt and blocks any attempt at adaptated education.

*We are speaking here only of children seen with their mothers. While severe affective deprivation is exceptional when the child remains in his family, it must be mentioned that in France abandonment at birth is quite frequent for babies born blind. According to an estimate in 1947, the proportion of blind children left to the care of Public Assistance (compared with the total number of blind children) was more than four times greater than that of children without any sensory deficiency.

DISCUSSION

1. It is obvious that many fields could not be explored within the limits of this account. Among these, the specific role of the father, his own reaction to the child's visual handicap, and the impact of his attitude on future identifications would all merit special study.

2. Many theoretical questions arise with regard to the affective adaptation of the congenitally blind child. With reference to Freud one may recall the primary importance attached to the "visual" (the eye, seeing, seeing-drive) in the establishment of object relations and the entire structuring of the psychic apparatus (Bourdier, 1971); it would seem that the study of those born blind could either confirm or radically undermine these theories. Quite obviously the problem could be posed only by enhancing the "sensory" lack (a lack which at this stage is experienced as such only by others) to the detriment of that which relates to "drive," as no equivalent of the seeing-drive seems to play such a prevalent organizational role in the human being.

   Ambiguity arises from the fact that not to see does not imply not to perceive, but that the object perceived is different from the object seen. Congenital blindness must, therefore, be studied as a *different* organization in which *we do not know* what the ways and means of substitution for the seeing-drive are. We only know that without external assistance spontaneous development occurs in a way which, compared with that of sighted children, evokes psychosis. But even in cases of nonpsychotic development the implications of these considerations with regard to key moments in affective development, such as the internalization of the object, the primal scene, and the discovery of the difference between the sexes still have to be defined.

We have seen how the internalization of the object may be achieved despite the delays and the setbacks of this achievement, whose modalities are linked to the dominance of the sense of touch. The *optical* representation of the object's Gestalt, which is global and instantaneous, is replaced by the fragmented representation, successively built up by degrees, of the *haptic* field of perception (Revescz, 1932). The abolition of distance immediately involves the dependence of perception on the object given to touch, and the difficulty of distance judgment.

Concerning the other two points, however, information is very inadequate. In the literature we have found no psychoanalysis of a congenitally blind adult. Psychoanalyses of children relate to autistic children, and direct observation of nonautistic blind children is invariably modified by the presence of the analyst and his active influence on the mother. We have personally been able to follow the cases of two blind adolescent girls during psychotherapy. The fantasies of primal scenes evoked in the course of treatment were striking for their terrifying and, especially, unlimited nature; the whole body was in imminent danger of being broken into by *something* equally limitless. In addition, it became obvious that the visual *lack* for them amounted to the absence of this *something* which they were unable even to connect with the penis as a real object.

This experience is plainly too fragmentary for us to be able to draw any conclusions, but it does enable us to consider the corrective role of sight in the representation of conscious fantasies, and its links with unconscious fantasies.

Another problem not attempted is that of the solution of the Oedipus Complex in the blind boy, owing to the fact that he has identification difficulties if he cannot live otherwise than castrated in the fantasy of others.

3. In practice, it is a complex problem to define to what extent this affective development underlies the integration of the blind in the society of the sighted. If the high quality of early development is a necessary condition of that of later development, it is certainly not sufficient, and we know how few people born blind in our country achieve proper socioprofessional and affective integration.

Lukoff and Whiteman (1970), studying the means of adaptation and their determining social factors in 500 blind adults, conclude that the degree and level of independence which they attain answers the expectations of the environment. This environment obviously covers the family, which is of course granted a dominant role, but it is widened to include the whole of society, and this poses again on a different level the problem of the attitude of the sighted towards the blind. It must be remembered that the contradictory fantasies of the impotent-omnipotent blind person are universal, and that they determine equally contradictory stereotypes (from the pathetic beggar to the blind genius). It is thus conceivable that certain educational and social structures intended for the blind reflect the ambivalences described for the microcosm of the family and in some way give them the force of law.

Hence, the "normal" blind child brought up to school age without particular overprotection most frequently finds himself segregated in an institution among blind children only, where learning clearly will take precedence over the blossoming of the personality. Despite the very favorable results of attempts at early integration of the blind child into schools for sighted children carried out in other countries, it should be noted here that in France no educational integration of blind children is provided for by law before the end of secondary schooling. This means that a

very small number of them benefit (the "blind geniuses") and that the great majority remain dependent on protected surroundings of assistance or attain professional autonomy only at a mediocre level (traditional trades). Hence, one of the essential functions of these closed and protected circles designed by the sighted appears to be that of protecting the latter from the phobogenic object, blindness, by freeing themselves from guilt through the rationalization of technical obligations.

4. In conclusion, we think it important to qualify the very general claim put forth in our introduction, that accordingly it is the inadequate attitude of the environment, and primarily of the family, which is responsible for the failure to adapt to blindness. Whereas one may give the family credit for the good adaptation of a blind child, one cannot invert the proposition without underestimating the complex elements which come into play. The absence of sight makes the child's upbringing genuinely difficult; it demands much greater virtues in the mother than those required for bringing up a sighted child. The necessity to adapt to the special needs of the blind child should not overlook the fact that these needs remain unknown. The quality of performance which some blind children achieve bears witness to very remarkable ingenuity on their part, but leaves untouched the profound lack of comprehension of the compensatory mechanisms which they bring into play. To our knowledge, only W. Brodey (1969) has attempted a comprehensive study of these mechanisms by placing himself in a group of blind students as an ethnologist faced with an unknown world, the blind students acting as informers. By living blindfolded for long periods he was able to experience at first hand to what extent the hypercathexis of sight in every sighted person suppressed (in the physiological sense of the term) the relevant information conveyed by the other sensory channels, and to measure the quality of this information. This writer reached the conclusion that while the sensory world of well-adapted blind people is different, it is in fact infinitely more rich and varied than the world of those with sight. However deserving of criticism the methodology may be, this path of study among others seems to be likely to lead to a more positive understanding of blindness, and to a demystification of that which, in familial educational, and social attitudes, is merely a projection of this *lack* which is in ourselves.

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APPENDIX

SCALE OF DEVELOPMENT FOR PRESCHOOL BLIND CHILDREN

The numbers alone refer to corresponding items of the Social Maturity Scale of Maxfield-Bucholz.

Maxfield, K. and S. Bucholz. *A Social Maturity Scale for Blind Preschool Children.* New York: American Foundation for the Blind, 1957.

The letters P, S, C, or L followed by a number and the age in months refer to the corresponding items of the Brunet-Lezine test.

Brunet, O. et I. Lezine. *Le Developpement Psychologique de la Premiere Enfance.* Paris: PUF, 1951, 129 pp.

The numbers preceded by HB refer to the corresponding items of the Hayes-Binet test.

Hayes, S. P. "Alternative Scales for the Mental Measurement of the Visually Handicapped," *Outlook for the Blind*, 1942, Vol. 36, pp. 225-30.

Hayes, S. P. "A Second Test Scale for the Mental Measurement of the Visually Handicapped," *Outlook for the Blind*, 1943, Vol. 37, pp. 37-41.

In the scale, First, Second... year refers to the real age of the child to be tested.

The number of months indicated after the items of Brunet-Lezine refer to the age at which there was successful performance by sighted children. (This explains why the second year of real age in the blind child may correspond to performance during the first year by sighted children.)

First Year

Postural	Sensory-Motor	Sociability	Language	Autonomy
1 -	2 -	S9 1 month	L8 1 month	
				S10 7 months
P3 2 months	C4 1 month	S10 1 month	C8 2 months	
				S10 10 months
P7 2 months	4 -	3 -	L8 3 months	
P1 4 months	C3 4 months	S9 2 months	L8 4 months	
				P7 9 months
P2 4 months	C6 4 months	S10 2 months	L8 4 months	
P1 5 months	C3 5 months	S9 3 months	L8 5 months	
P1 6 months	6 -	S9 4 months	L8 6 months	
P1 7 months	7 -	S9 5 months	L8 7 months	

First Year (Continued)

Postural	Sensory-Motor	Sociability	Language	Autonomy
P1 8 months	C3 7 months	S10 6 months	15 -	
5 -	C6 9 months	12 -	L8 10 months	
P1 9 months	8 -	S9 9 months	16 -	
11 -	9 -		L8 12 months	
19 -	10 -			
P7 9 months	13 -			
	14 -			
	17 -			
	20 -			

Second Year

25	29	S9 10 months	22	27
P1 10 months	C2 10 months	S9 12 months	32	PL 12 months
26	C2 10 months	S10 12 months	37	31
P1 12 months	C5 10 months	34	L8 15 months	33
P7 12 months	C6 10 months	24	L8 18 months	35
P1 18 months	C2 12 months	S9 6 months	L9 21 months	P1 15 months
P1 21 months	C5 12 months	S9 7 months	L8 24 months	P7 15 months
	C2 15 months			P7 18 months
	C3 15 months			P7 21 months
	C4 15 months			
				23
	C5 15 months			
				28
	30			
				38
	C2 18 months			
				S9 18 months
	36			
				39
				21
				40

Third Year

Postural	Sensory-Motor	Sociability	Language	Autonomy
P1 24 months	42	45	44	50
P1 30 months	46	HB3	51	41
	47	HB4	L9 24 months	43
	48	S10 24 months	L8 20 months	49
	54	S10	HB6	55
	HB2			P7 24 months
	C2 24 months			P7 30 months
	C2 24 months			52
				53
				S9 30 months

Fourth Year

Postural	Sensory-Motor	Sociability	Language	Autonomy
	69	62	61	57
	HB6	69	64	56
		HB1	66	65
		HB6	70	67
		HB5	HB4	60
				68
				58

Fifth Year

Postural	Sensory-Motor	Sociability	Language	Autonomy
	79	71	81	
				74
	80	72	83	
				78
	85	77	HB1	
		82	HB2	75
				76
				84
				73

Sixth Year

Postural	Sensory-Motor	Sociability	Language	Autonomy
	86		HB1	
				93
	94			
				90
	95			
				87
				89
				88
				91
				92

Brunet-Lezine

First Year

Postural

P3 - 2 months Lying on back, holds head erect when pulled by the forearms to a seated position

P7 - 2 months Turns self from side to back

P1 - 4 months When lying on stomach, keeps legs extended

P2 - 4 months Lying on back, lifts head and shoulders when gently pulled by the forearms

P1 - 5 months Stays seated with slight support

P1 - 6 months Held vertically, supports part of own weight on feet

P7 - 7 months Passes toys from one hand to the other

P1 - 8 months Lifts self to a seated position when slightly pulled by the forearms

P1 - 9 months Can remain standing with support

P7 - 9 months When held under the arms, makes walking movements

Sensory-Motor

C4 - 1 month Reacts to bell

C4 - 3 months Holds a rattle firmly and shakes it with sudden, involuntary movements

C3 - 4 months When seated at the table, fingers the edge of the table

C6 - 4 months While lying on back, shakes the rattle placed in hand and listens to it

C3 - 5 months Grasps a block when it is placed in contact with hand

C3 - 7 months Grasps two blocks, one in each hand

C6 - 9 months Rings the bell

Sociability

S9 - 1 month Ceases crying when approached or spoken to

S10 - 1 month Begins sucking reaction in anticipation of feeding

S9 - 2 months Stops moving or turns his head when spoken to

S10 - 2 months Smiles at familiar voices

S9 - 3 months Becomes animated at the perception of feeding preparations

S9 - 4 months Laughs out loud

S9 - 5 months Uncovers self by articulated kicking; grasps own thigh or knee

S10 - 6 months Distinguishes between familiar and strange voices

S9 - 9 months Reacts to certain familiar words

Language

L8 - 1 month Emits small guttural noises

L8 - 2 months Emits several vocalizations

L8 - 3 months Babbling: prolonged vocalization

L8 - 4 months Vocalizes when spoken to

L8 - 5 months Utters cries of joy

L8 - 6 months Makes trills

L8 - 7 months Vocalizes several well-defined syllables

L8 - 10 months Repeats a sound that has been heard

L8 - 12 months Can say three words

Autonomy

S10 - 7 months Can eat a thick cereal with a spoon

S10 - 10 months Drinks from a cup or a glass

P7 - 9 months When held under the arms, makes walking movements

Second Year

Postural

P1 - 10 months When standing with support, lifts one foot and puts it down

P1 - 12 months Walks with help when someone holds hand

P7 - 12 months When standing, bends to pick up a toy

P1 - 18 months Pushes a ball with foot

P1 - 21 months Kicks the ball, after demonstration

Sensory-Motor

C2 - 10 months Finds a toy hidden under a napkin

C3 - 10 months After demonstration, puts a block in a cup without releasing it (or takes it out of the cup)

C5 - 10 months Takes the round form from the board

C6 - 10 months Looks for the clapper of the bell

C2 - 12 months Picks up a third block while keeping the two already in possession

C5 - 12 months Puts the round form back into the hole on the board

C2 - 15 months Constructs a tower with two blocks

C3 - 15 months Fills a cup with blocks

C4 - 15 months Introduces a tiny object into a bottle

C5 - 15 months Puts the round form into the hole on the board when requested

C2 - 18 months Constructs a tower with three blocks

Sociability

S9 - 10 months Understands an interdiction, stops doing something when requested

S9 - 12 months Gives an object by request

S10 - 12 months Repeats actions which have provoked laughter

S9 - 6 months Takes own feet in hands

S9 - 7 months Puts feet in mouth

Language

L8 - 15 months Can say five words

L8 - 18 months Says at least eight words

L9 - 21 months Asks for food and drink

L8 - 24 months Makes sentences of several words

Autonomy

P1 - 12 months Walks with help when someone holds hand

P1 - 15 months Walks alone

P7 - 15 months Climbs stairs on all fours

P7 - 18 months Climbs stairs standing when someone holds hand

P7 - 21 months Descends stairs when someone holds hand

S9 - 18 months Feeds self with a spoon

Third Year

Postural

P1 - 24 months Kicks a ball on request

P1 - 30 months Tries to stand on one foot

Sensory-Motor

C2 - 24 months Constructs a tower with at least six blocks

C5 - 24 months Puts all three forms in the board

Sociability

S10 - 24 months Helps to set own things in order

S10 - 30 months Does not wet bed at night

Language

L9 - 24 months Calls self by own name

L8 - 30 months Says "I"

Autonomy

P7 - 24 months Climbs and descends stairs alone

P7 - 30 months Can carry a glass of water without spilling

S9 - 30 months Puts on own slippers

SONIC GLASSES FOR THE BLIND

A PROGRESS REPORT

Leslie Kay*

INTRODUCTION

Many inquiries have been made during the current evaluation of the Binaural Sensory Aid for the Blind (Sonic Glasses), and some form of progress report seems justified. We have now learned a great deal about the potential of the aid, and know some of the problems associated with introducing it to agencies and blind people. Its future remains uncertain because the next step requires a great deal of effort, and the resources for this have yet to be committed.

An evaluation of the device has been underway in the United States and the United Kingdom for over 12 months. This report is the first of several planned between now and mid 1973 when the evaluation will be complete. It covers the principles of the device and its evaluation; discusses some of the factors which will influence the results; describes what a blind person can expect to gain from the use of the glasses; and finally outlines the policy for the introduction of the glasses should the demand for them be adequate.

A second report will appear in a subsequent issue of the *Research Bulletin* and will contain the results of questionnaires sent to teachers and users of the aid. An independent report by the questionnaire designer will be appended.

Later reports will cover detailed aspects of training both teachers and users. A final report will indicate the level of user acceptance after a period of use of up to three years, and speculation on the ultimate potential of the aid in the long term.

THE DEVICE

The present device is little more advanced than the experimental model used in New Zealand in 1970 consisting of a set of frames similar to those of optical glasses with three small disc-like elements (transducers) fitted into the frame above the bridge. The lower one converts electrical signals into very high-frequency (ultrasonic) sounds and the two upper elements convert the ultrasonic echoes into electrical signals to be amplified in the receiver electronics.

Connected to the spectacle frames by a multicore cable is a control box which houses these electronics, the 12-volt rechargeable battery, and the control switches. The battery has a useful life of about four hours before requiring a recharge from a special battery charger. (Figure 1.)

The electronics produce high-frequency signals for the transmitting transducer which radiates ultrasonic waves in a cone of approximately 60 degrees in front of the user. The frequency of transmission varies continuously between 45 and 90 kHz, which is three to six times higher in frequency than the highest sound audible to most people. Objects in the field of radiation reflect some of the ultrasonic energy

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Figure 1. Ultrasonic Binaural Sensory Aid for the Blind

back to the user. To indicate the arc of cover, two objects ten feet apart at a distance of ten feet may both be just in the field of view.

The echoes are intercepted by the two receiving transducers. The electronics change the high-frequency electrical signals into audible sounds which emanate from the miniature earphones mounted in the side frames of the glasses. The transducer on the right of the bridge-piece ultimately feeds echoes to the right ear, and the left transducer feeds echoes to the left ear. This produces a stereophonic effect similar to that heard when using stereo headphones. It is not the same as listening to stereo loudspeakers. The miniature earphones are coupled to the ear canals through a small unobtrusive plastic tube which leaves the ear completely free to pick up all ambient sounds from the surrounding environment. *This is a very important feature of the glasses. Very special care has been taken to preserve all auditory sensations experienced by blind people, while at the same time, making it possible to listen to sounds from the device.* This fact is confirmed by all who use the aid correctly, whether they have a natural ability to sense objects through their sense of hearing or not.

There are three important features in the sounds produced by the glasses:

1. The pitch of the sound is proportional to the distance of the object producing the echo. In the present device a wall at a distance of 20 feet produces an echo with a pitch corresponding to 6000 Hz. This is a very high-pitched sound and about the maximum which can be heard with the device.

   (Note: It is quite easy to change the electronics so that a wall at 40 feet can be heard. Conversely, the maximum range may be reduced to ten feet. However, there are reasons why the present choice of 20 feet may have advantages.)

2. The quality of the sound, or its timbre, indicates the nature of the surface producing the echo. Thus, one may "look" at a pole and a bush simultaneously within the 60 degree field of view and recognize each as independent objects through their different characteristic sounds. They could be obstacles one wished to avoid or ignore, or they could be recognizable landmarks to be used for navigation.

   The difference between the sounds in the left and right ears enables the user to determine the direction of the object producing the echo. The perception of direction is more truly binaural than stereophonic, since the relative position of the sounds changes with head movement. This cannot happen using stereophonic headphones. If we consider the example given above where a pole and a bush were viewed simultaneously, the pole could appear to be on the right at one o'clock at a 12-foot distance, while the bush may appear to be on the left at

11 o'clock at a six-foot distance.

Fortunately, the range at which an object may first be detected depends upon its size and the angle from which it is viewed, otherwise there would be too many sounds to listen to when traveling through a complex environment. Normally a wall can be detected at a distance of 20 feet; some objects, such as parking meters, may not be detected until their range has been reduced to approximately six feet. The blind person is taught how to pay attention to some sounds and ignore others, while at the same time using other ambient cues.

TRAINING

Before a blind person can use the aid effectively, he must be trained by a qualified skilled instructor. Most of the blind people now using the glasses were previously taught mobility by the long cane system, the mechanics of using a long cane in conjunction with the ambient cues available to their remaining senses. Many were also competent and experienced travelers. Some were previously trained to use a guide dog, and now use the glasses in conjunction with the dog.

A qualified instructor in the United States is either one who is eligible for certification by the AAWB or is a fully trained and certified guide dog instructor, *and* has undergone a special course of training in the use of the Sonic Glasses. There are now twenty instructors in the United States, and eleven in New Zealand, Australia, and the United Kingdom.

The course of instruction for a teacher currently lasts four weeks. Three courses have been held in the United States, two at Boston College and one at Western Michigan Rehabilitation Center under the sponsorship of the University of Western Michigan. We now think the course should be extended to include practical experience in training a blind person.

Blind people are also being given a course of instruction lasting approximately four weeks. This follows their training in the use of the long cane or a guide dog. Some learn to use the device effectively with 30 hours of training, but indications at present suggest that a training period of 60 hours, plus an additional 30 hours of practice would be more effective.

If the training period is too short the user may become easily confused by complex situations, or it may be that he has quickly learned to ignore much of the useful information available and will thereby use the device only in its simple mode as a clear path indicator. Neither of these responses is satisfactory when more may be achieved.

The majority of orientation and mobility teachers are against training novice travelers at this point in time because so little is known of the problems of training. When instructors have had more experience this viewpoint may change, and they may become more ready to train the novice using a modified teaching format. *Optimally, this must be arranged to combine the cane, the glasses, and the ambient cues.*

Future training of instructors in the United States is yet to be determined, but it is hoped that the universities presently teaching orientation and mobility specialists will arrange courses.

EVALUATION FORMAT

In planning an evaluation program, it is essential that the aims be clearly defined. These are found in Appendix B as "lesson notes" for the training course instructors.

Five groups of people are interested in the evaluation:

1. Blind people, who form the most important group.
2. Administrators, who organize the rehabilitation programs and seek the funds for their support.
3. Instructors of the blind.
4. Researchers, who seek knowledge of the new man/machine system.

5. Device designers.

All have different interests, which might not always be compatible. On the assumption that one could expect a high degree of compatibility among the first three groups, the program was designed to emphasize their interests.

Thus, eight rehabilitation centers in the United States became involved employing 18 instructors to train up to 124 blind people. The funds for the evaluation were provided by The Seeing Eye, Inc.; the Department of Health, Education, and Welfare; and the Veterans Administration. The program was organized this way partly by design and partly through the force of circumstances.

Training began in four centers in June, the fifth started in September, and the remaining three in November of 1971.

Paralleling this major program was the training in New Zealand and Australia which had already been in operation for 18 months. Training was also begun in the United Kingdom by one instructor who trained in the United States during the first course.

At this time, May 1, 1972, 142 devices are in the field and approximately 100 blind people have been trained. A number are under training. It is planned to train approximately 200 people during the current program.

Each training center in the United States and the United Kingdom is monitored by the evaluation team based at Boston College. In addition, an engineer from the manufacturer is resident with the team to provide engineering service.

While it may appear that the evaluation is being supervised by the group directly concerned with its design, it is actually being effectively carried out by independent orientation and mobility specialists who are supervised by their administrators and monitored by their blind students.

EVALUATION PROCEDURE

A more complex form of evaluation, as described in the appendix, may have been possible, but the final procedure was simple.

It was first essential to convince the orientation and mobility specialists, who have been skeptical of the value of electronic mobility aids, that the Sonic Glasses were potentially useful to blind people. Without this conviction, they would not be adequately motivated to add to their existing work load the task of teaching blind people to use the glasses. The first course of instruction, held in April-May, 1971, was designed to provide the basis for this conviction. Each teacher, under blindfold, was given the opportunity to work with the glasses extensively.

As an educational exercise, the best methods for training a teacher unfortunately were not used, but it was felt that these would come later. As an evaluation exercise, however, the course was outstandingly successful. All but one of the 11 teachers had taught blind people, mainly under difficult administrative circumstances. Two have left the program for purely personal reasons.

Six more instructors were trained in a second course held in September-October, 1971. Again, there was heavy emphasis on working with the glasses under blindfold. There was a better overall approach to the teaching, and the basic skepticism of electronic aids was much reduced. All six instructors are teaching the use of the glasses.

During February-March, 1972, a third course was held for the last two teachers to be trained under the present program. The approach was changed. More emphasis was placed upon teaching methods, rather than training the teacher to use the glasses under varied and complex travel situations. This was followed by partially supervised teaching of the first blind student, resulting in a greater competence in teaching. On completion of their

course the two instructors probably had more conviction of the potential of the device than did previous instructors.

The Sonic Glasses through these three courses were exposed to a highly critical test--a personal evaluation by 18 teachers, all fully qualified, experienced orientation and mobility specialists. No one expressed a serious doubt about the device. Other instructors who taught the use of the glasses also concurred.

Factors known to affect mobility performance are:

1. Teaching skill
2. Duration of training
3. Personality of trainee
4. Device performance and reliability
5. Organization of facilities

Through the experience of the instructors with their trainees, a great deal has been learned. They have gained expertise in teaching, can now assess the potential of the device when used effectively, and can identify patterns of behavior from which to determine user population. Essentially, these are the basic reasons for evaluation.

If a significant proportion of both blind people and their instructors accept the device, the aid must be useful at an adequate level. Thus, the opinion of the teachers who are now involved, and the 200 blind people who are to be trained, will be sought through professionally designed questionnaires. This will be the evaluation "instrument." Any other information which is gathered will be a bonus. Objective measures of mobility are still so controversial that they would be unreliable. Few of the instructors have shown a strong desire to measure mobility objectively, and where it is being done, only very simple measures are being taken. All agreed that a searching questionnaire would be acceptable. Many frustrations have been experienced, however, and the effects of these may linger for a long time. The really important part of the evaluation is, of course, the man-machine performance.

MAN-MACHINE PERFORMANCE

This is an important aspect of the Sonic Glasses, since they are probably integrated into the user's sensory system more than most other physical aids. The environment is perceived to change when the body moves yet the world stays stationary--as with our senses. The glasses, in fact, provide a new sense. They are not "obstacle detectors" or "clear path indicators." Determining the performance of a person using such a sensory aid is, therefore, very complex.

Consider two actual cases as examples. Subject A is an aggressive, outgoing, highly intelligent, young, blind woman attending a university. She wants to be free to travel in the city independently, and is determined to do so. The long cane and the glasses make this possible without great stress. Qualified judges observed her visit to a shopping center. Her mobility was such that she blended naturally into the shopping throng, and on one occasion she eluded the notice of the observer. A number of objective judgments can easily be made in such a situation, and the score would be high by any standard.

Subject B is a nervous, shy, petite person who finds travel as a blind person mentally exhausting, so much so that she required nearly an hour of rest to recover from the effort of traveling over the one semi-residential suburban block between home and office. She had no ambition to be independent--the thought of it was too much to contemplate. However, after patient training with both the long cane and the glasses, she gradually found that the daily journey was no longer a trial of courage. She did not require a period in which to recover, and she has begun to be outgoing in her attitude. One day she visited the hairdresser on her own for the first time. Objective measures of her performance would have been useless--the thought of being observed would have immobilized her.

Subject A can travel well with the cane alone; Subject B cannot even travel without the glasses, and when she does travel with the glasses, it is not with the grace of A. Who benefits most, and how is this objectively measured?

With this kind of performance variable, is it possible to say how much a blind person may ultimately benefit from the glasses? Some of us prefer to listen to music rather than to watch television; others have eyes which constantly see beauty in their surroundings, while some never do. We all use our senses according to transient inclination, and so it is with the new sense now provided for the blind by the Sonic Glasses. We can say what we now believe is possible through good teaching; we cannot say what a person will do with the newly acquired capability.

The following data is the background from which I formed by opinions:

Qualified Instructors

Australia	7
New Zealand	3
USA	20
UK	1
Total	31 (including four guide dog trainers)

Blind People Trained as of May 1, 1972*

Australia	30
New Zealand	14
USA	44
UK	16
Total	104

*The number increases daily.

Age Range

Minimum	Average	Maximum
16	35**	55

**Best guess, statistics not yet available.

Degree of Blindness--Total

Intelligence

generally average and above

Prior mobility

novice travelers	10
experienced travelers	
a. long cane	74
b. guide dog	20

Continued users of Sonic Glasses

since August 1969	1
since August 1970	10
since August 1971	30
at present	104

The growth of numbers is progressive.

Drop-outs

female	4
male	4
Total	8

The reasons for rejection are uncertain and complex, but in four cases it is known that the training was inadequate and could have been a major contributor. One person should not have been included because of a significant hearing loss. One guide dog user believed that the device interfered with the dog's performance. However, this person was not trained to use the glasses with the guide dog. Three disliked their appearance with the glasses and this may be an overriding factor.

PERFORMANCE-TRAINING CORRELATION

It is becoming evident from observation at the various centers, that training is a major variable. In general, where training has been good, both performance and motivation toward the aid tends to be good. Where the training is less adequate, performance is variable. There does not appear to be the same correlation between personality and performance. Length of training must be flexible to achieve good results, and it is here that the personality variable should be accommodated. It

may be noted that the term "performance" is being used without definition. The teacher is usually a good judge of his results even if the teaching has not been entirely satisfactory. In consequence, considerable weight has been placed upon the judgment of the teacher. The quality of the teaching can be assessed by the motivation, enthusiasm, knowledge, and effort of the instructor. Where the insight of a teacher is poor or the ability to explain lessons is lacking, it is obvious that the teaching will not be good.

Thus, when I refer to performance, I am really expressing the teacher's assessment of the improvement seen during the training. A gifted traveler may not show much improvement in travel ability, but may have enthusiastically expressed appreciation of the increased awareness of the environment and have shown a reduction in stress. This would be rated highly. On the other hand, had there been no positive reaction from this kind of person, the rating would be low--but it would also be questioned.

At the other end of the scale, a person who cannot travel beyond his home with the long cane alone, without fear of personal injury, gets a high rating if, with the aid of the glasses, he will go for a nightly walk just to exercise. The rating, however, would be low if no improvement of any kind were seen in the travel behavior.

These two possibilities are in fact actual cases. Where the performance rating is low, the training is more likely to have been either poor or inadequate, but this is evident only now, and should not have biased the judgment of the teachers at the time.

TRAINING VARIABLES

Contrary to popular understanding, training a blind person to travel safely and gracefully is a skilled art. There is much that could be said about this after many years of exposure to the "blindness system," but all I need say here is that too few appear to have learned to be highly mobile. This must be evident to many who come in contact with blind people. When the only aids a blind person can use are a cane and his perception of ambient cues, the teacher has an exceedingly difficult task. I am completely convinced of this now. What is achieved today is very significantly better than the mobility seen before orientation and mobility became the profession of specialists. Yet it could be better if the basic environmental information was more adequate. Teachers working with such limitations often regress to a "mechanical" procedure. In a number of places mobility is taught by giving a specified lesson each day until the series of lessons is completed--regardless of progress made by the individual. Where the teacher has insight, is capable of innovation, and understands the basic principles upon which to build, the story is different.

Within a period of four weeks, during April and May, 1971, the stagnation which we have seen in mobility training was shattered. Few even now appreciate this. No longer do we have to teach mobility through the indeterminate use of ambient cues and the mechanical manipulation of a cane alone--we can teach spatial perception itself. Yet who can expect a teacher with little background in the physics or psychology of perception to learn to teach it effectively in only four weeks, and in addition, integrate it with the mechanical skills previously taught, and the existing use of ambient cues largely learned through an exploratory experience.

Here we built into our evaluation the greatest variable possible. Some teachers, even after twelve months, have not yet seen the full potential of the new system, while others are using it more with each student.

When you add this to the simple fact that we knew little of how to teach the teacher, it will be readily appreciated that the outcome, for a time, was in balance. The only safeguard lay in the numbers being involved. Some were expected to "find the way," and they did.

There was an additional hazard that we underestimated. The concept of monitoring and assisting teachers was built into the program and we did not anticipate the problem that many teachers met on returning to their respective centers: organizing the facilities and services; training areas, audiological and optometrist services, recruitment of students, timetabling of lessons, etc., placed a heavy burden on the teacher. When the first client arrived, every step in the training program had to be taken for the first time.

There can therefore be no doubt that training is a major variable which must influence the results. The question which must be asked is "to what extent?" We may find out later.

DEVICE VARIABLE

In the early stages of the evaluation the devices were thought to be unreliable. They were, but not for all the reasons expressed by the teachers.

The direction cue we provided was erroneously reduced to near ineffectiveness in some cases. This came about as a result of trying to control the device parameters; however, a detailed explanation would have been too involved to the instructor with little experience. The error was not obvious. When trainees had difficulty with some of the training tasks in the early stages, devices were returned as defective. The common complaints were: (a) too noisy, (b) had clicks or thumps which should not be there, (c) following a guideline was difficult due to confusion between ground signals and guideline signals, etc.

There arose a strong conflict of opinions about device performance, because the understanding of the device in a mobility setting was very limited. Some members of the evaluation team did not have any mobility experience, and those who did held differing points of view. The situation was quickly resolved when the error in the direction cue of the Sonic Glasses was discovered. In many devices it had been less than half of what it should be. However, by then the noise factor had been improved, the source of clicks and thumps removed, and following a guideline was immediately improved by the correction of the error. Gradually, we are improving the performance of the device by learning the factors which most influence the man-machine performance. Remember, it is an entirely new and complex system about which we have much to learn.

Nevertheless, the early models would have been easier to use had the error not been present. This is evident from the results obtained in Australia and England. There the direction cue was adjusted by the teacher to suit an individual, if it was seen that there was difficulty in using it. To ensure more control of device parameters, no adjustment was allowed in the field in the United States.

Hence, in the early stages of the evaluation, the device introduced a variable, and it could well have been as important as the training variable.

The device is now more carefully controlled, and the variable is small.

TRAINEE VARIABLE

What we seek to find out is whether, with a good device and good training the spatial perception of an individual will be enhanced and his mobility improved.

What we have to establish are guidelines by which we can gauge the potential improvement in an individual. At present these guidelines will not cover a very wide range of the blind population. Initially, I planned to have both novices and experienced travelers trained. After a short time, the instructors insisted on reducing the variables by having only totally blind experienced long cane travelers trained. This limited the people from whom to choose, and we cannot assess the potential of the aid to the novice *who should find it most beneficial*, except for those who have been trained in New Zealand.

The reader will have to judge for himself what he thinks is possible.

EXPECTED GAINS FROM THE USE OF SONIC GLASSES

I am forced to give personal opinions at present, but I am satisfied that they are well substantiated. Let us assume that we have learned how to teach well, the facilities for training are adequate, the glasses are well-fitted, the user's hearing is normal, and the level of physical fitness enables travel on foot.

Then, for the greater majority of people trained:

1. The Sonic Glasses will considerably improve an individual's awareness of the environment. For some, the improvement may have little value, but for others it will be exciting. There seems to be no way of predicting.

2. The stress of travel will be reduced no matter what travel capability a person has. In some cases, this may not be an important factor--an aggressive traveler will probably remain aggressive. For many, however, the reduction in stress may mean continued travel ability not possible without the glasses.

3. All travelers should be able to exhibit more grace in their movement because of better control of their body position in relation to the surrounding environment.

4. Pedestrian traffic will not present the same embarrassing situations or hazards as with the cane alone. Those travelers who are capable of reaching downtown areas, and need to travel in them, will undoubtedly benefit from the glasses.

5. Negotiation of shops and offices becomes less of an ordeal. Shop assistants can be sought and found by some users.

6. Navigation through the use of recognizable landmarks is now possible, in addition to what can be gleaned from existing ambient cues.

The all-important question a blind person may ask is how does this come about?

In essence, the secret lies in an ability to sense the environment--no matter how crudely--so that movement is not a hazard. There have been many pockets of resistance to this concept, among them several scientific colleagues. Even now some keep insisting that a blind person requires only a simple display which is easily learned.

SUBURBAN TRAVEL

In a suburban area, the environment is randomly structured and one cannot readily predict what will be found. It has been designed to appear attractive to the eye and to make it a pleasant place to reside. There are trees, shrubs, grass lawns, occasional mail boxes, lamp posts, street signs. The boundaries of the sidewalk vary in structure--grass, railings, low hedge, wall, and stone banks. In such an environment, a user of the Sonic Glasses has to become very competent in distinguishing the various sounds he hears if he is to make full use of the information available to him. Certainly 40 to 50 hours of training alone is not sufficient. Practice is needed, but when one can use the sounds effectively, the reward is apparently considerable. *Some blind people now say the glasses provide worthwhile information in giving them a sense of their environment at a pleasurable level.* There is no "value" in knowing the leaves are breaking out on the trees, but at the time of writing we are all looking for the buds to burst. Why should a blind person not have this pleasure when it is now available to him in the language of sound?

Hence, the benefit of the glasses near one's home in suburbia may be largely for pleasure and exercise without stress. If this is possible, the task of walking *to* the business area is easy.

BUSINESS AREA TRAVEL

In a business area, the life style is very different and so is the environment. It is well structured in a regular pattern. The sidewalk is bounded by the road with traffic on one side and buildings on the other. Architects have tried to maintain a measure of beauty in their buildings and in consequence the travel boundary formed by them may vary considerably; it may not be straight. A blind person traveling with only the long cane in this environment is usually intent on getting to his destination and has only a vague idea of what to expect on the way. What is almost certain is that he must avoid colliding with pedestrians. A few pedestrians may be unnerved by his presence and forced either by sincere concern or the need to be relieved of the feeling of apprehension to take his arm and "guide."

With the glasses a blind person can be taught to travel in business areas in such a way that few would notice him, or at least they would not feel they needed to offer assistance. When the traveler wants help, it can be easily solicited by seeking out a pedestrian. Herein lies the key to the concept. When traveling the length of the block, there may be no more interest in the boundaries of the sidewalk than merely being aware of their presence from which to take a guideline. But the traveler may well wish to ask for directions. *Suddenly the glasses become a means for distinguishing a pedestrian from a pole or any other thing which may produce an echo.* Imagine two sighted people standing nearby as the blind traveler passes. He turns to ask for directions, but as he does so the pedestrians become silent, looking at him. In an instant, he is at a loss: "Have they moved on?; Are they just looking?; Will they offer to help?" The glasses remove this embarrassment; the recognizable pedestrian sound is heard and the position of the two people is immediately perceived. It is easy to walk up to them and say, "excuse me," confident that one is not speaking to an inaminate object.

It is important when traveling in a business area walking in the same direction as other pedestrians, that one should maintain the same speed as others, blending into the flow and not causing "turbulence." This has become possible with the glasses which give a constant indication of the distance between the traveler and the people in front of him. Any change is immediately registered and corrected. If someone steps into the gap suddenly, the gait can be altered to accommodate this intrusion, and the traveler drops back slightly to allow room for his cane again.

If, however, the traveler is approaching oncoming pedestrians, things happen quickly. Either there is a hurried apology, or there is no incident. With the glasses, most encounters with pedestrians can be avoided. Usually the pedestrian, having noticed the cane, takes the necessary action. When he does not, quick reaction is required on the part of the blind person. There is no time to think whether to go right or left. The binaural direction information, combined with the changing range, allow the user subconsciously to move to the side which will be least hazardous. *Rate of change* of position is the dominant cue to which one *reacts, not thinks.* This reaction has been observed on film. A blind person is seen to have taken the correct initiative and avoided an approaching baby carriage. A *simple* display will not provide this facility.

CONGENITALLY AND ADVENTITIOUSLY BLIND

The question has often been asked, what of the difference between the congenitally blind and the adventitiously blind and their use of the glasses. Both use the glasses equally well, and at top level of competence. However, during the early stages of training, there can be serious difficulties due to body image and spatial perception problems. The adventitiously blind can mentally visualize the world in three dimensions, and consequently are more readily able to relate the sounds of the device to the distance moved to reach an object and the concept of space as a mental image. We do not know what the congenitally

blind person perceives; the verbal response and the physical behavior may be the same, but there is no reason to believe that the mental image is anything like that of a person who once had sight.

The simple concept of "direction" may confuse the congenitally blind. One person could not understand why the glasses did not produce a signal from a low wall which his cane was touching. He knew it was a low wall, but did not appreciate that to look at it he had to lower his head. Even the simple term "lower" his head could mean "bend down" rather than "look down." It is fairly common to find in the early stages that a trainee will "look" in one direction yet commence moving in another slightly different direction. Thus, when setting out on the first exercise to grasp a pole 10 feet away, the head may be looking at the pole, but the body will move to the side of it. Sonic contact is then lost and a searching process starts. It is important that this behavior be corrected. There seems to be no more effective way of correcting such body image deficiencies in a blind person other than through the use of the glasses, which enhance spatial perception.

So in fact we are not only concerned with mobility, as it is commonly thought of, we are really concerned with developing natural behavior in movement.

CONCLUSION

What has the evaluation told us? Two important facts:

1. Almost all of the 31 teachers who have learned to use the aid and have now taught blind people want to continue teaching the use of the glasses about half of their time, which would mean that they could teach about ten blind people per year. Some wish to teach use of the glasses full time.

2. Of the 100 blind people who have been taught to use the glasses, only eight so far have declared that they do not need them. Inadequate training could be at the root of our failure in some of these cases. The success rate is high, in excess of 90 percent, despite the facts that the device was in its early stages of development, the teaching was unpolished, and in many cases the training time was too short. Where the training was of superior quality and the devices worked well, the success rate exceeded 95 percent.

   This is more than any of us hoped for, and clearly indicates the ultimate potential of the system we can now introduce.

I believe that all the other facts that have emerged are secondary.

We have yet to learn of long term acceptance; while in some cases the device has been in use for well over a year, most users have had the aid a relatively short time.

THE FUTURE

This is in the hands of the instructors. A policy has been established which prohibits blind people from getting the glasses without proper training from a qualified teacher. There can be no other successful policy since all blind people must learn to *use* the glasses. It would be a most unusual, highly gifted, and remarkable person who could learn without formal training.

Through skilled teaching over an adequate time period, success in the use of the glasses is assured. Those very few blind people who could learn to use the glasses without formal training must concede the advantage of giving the very great majority good service.

Courses to train instructors will be held, and only those agencies who have trained instructors can obtain the glasses. Because the training of instructors demands experienced specialists, instruction can be given only at special centers: such as Boston College and the University of Western Michigan.

Colleague cannot teach colleague! Many have hoped this would be the case, but the teaching would be inadequate. Technical back-up is required.

ACKNOWLEDGMENTS

The evaluation has been carried out by many people, all of whom have played a major part. The teachers, however, must be given special recognition since they were exposed to a new technology without adequate preparation, and had to suffer the frustrations which attend the introduction of a new technological device. Their task was to teach while maintaining enthusiasm in the blind student. This they did when at times the problems seemed insufferable. Without their cooperation we would not have had our results.

My colleagues on the evaluation team, N. Bell, D. Rowell, W. Keith, and S. Nicholson, require special mention. All were away from their homes for many months. Only a strong commitment to, and beliefs in the aims of the project sustained them during many disturbing periods. They solved many knotty problems which might have been fatal to the program.

None of this would have been possible without the very generous financial support of The Seeing Eye, Inc. The Department of Health, Education, and Welfare; the Veterans Administration; St. Dunstan's; Royal Guide Dogs Association of Australia; Royal New South Wales Institute for Deaf Blind Children; Royal Victoria Institute for the Blind; New Zealand Foundation for the Blind; and the Australian Association for the Blind provided funds for the purchase of aids and the provision of teaching facilities.

The cooperation of the following organizations and agencies is sincerely acknowledged as they carried the brunt of the teaching load: Boston College; University of Western Michigan; St. Paul's; The Seeing Eye, Inc.; Illinois Visually Handicapped Institute; Veterans Administration Blind Rehabilitation Centers at Hines, Palo Alto, and West Haven; National Mobility Centre, Birmingham, England; Arkansas Enterprises for the Blind; and agencies already mentioned in New Zealand and Australia.

Above all, however, I wish to thank most sincerely all the blind people who gave of their time, arranged leave of absence from work, left home for several weeks of training, and risked disappointment in order to learn how to use the glasses. They were all remarkably cooperative and understanding. It is through them that I believe a significant step forward has been taken in the field of mobility.

The University of Canterbury, New Zealand, cannot be forgotten; my professorial colleagues and The Council approved my eighteen month leave of absence to supervise the program when I should have been shouldering the duties of Dean of Engineering. This was a most remarkable gesture for which I am very grateful.

APPENDIX A

EVALUATION OF THE ULTRASONIC BINAURAL SENSORY AID FOR THE BLIND*

THE DEVICE

DEVICE OBJECTIVES

The sensory aid has been designed to give a blind person a percept of his environment through his auditory senses at a level significantly higher than his unaided senses will allow. The hypothesis underlying the principle was based upon the apparently well known fact that after the visual senses the auditory senses were capable of handling the most information. It seemed only necessary to so code the information that it was processed optimally by these senses, and was in a form which readily enabled a person to perceive the environment from which the information was gathered.

This information is in the form of reflected signals from inhomogeneities in the environment, and when the illuminating source is light the total information is high and exceedingly complex. The eye has been evolved to handle this effectively and any alternative to vision must involve some information reducing element; at this stage of our technology, the reduction must be considerable. One very effective way of doing this is to increase the wavelengths.

The binaural aid uses ultrasonic waves which cover a wavelength range of 2.5 - 5 mm. Light has a wavelength of the order of 10^{-4}mm so that the use of ultrasonics immediately introduces a reduction in information of the order of 50,000. This makes it more compatible with the auditory system. The auditory bandwidth which can be usefully used is approximately five KHz, but the bandwidth of the information carrier in the medium using ultrasound may be of the order of 50 kHz. Bandwidth compression is therefore necessary and is readily achieved using the Continuous Wave Frequency Modulation transmission. An input band of 50 kHz is effectively compressed to five kHz in the sensory aid, thus producing an overall reduction in information of 500,000 compared with vision.

The sawtooth modulation of the transmission frequency used in the aid is an ideal code for providing optimum matching to the ears. The cochlea may be looked upon as a spectrum analyzer which matches to the range coding of the binaural aid, and the whole system can be shown to form a "matched filter." This is the best which can be achieved in information transfer from the "medium" to the "display." (The *display* in the context of this paper is the *auditory percept* obtained by the observer.) The range due of the device is thus simply described as echo pitch proportional to distance with 300 Hz corresponding to one foot. Built into this system is the facility to perceive quality (timbre) of the echo indicating the surface from which the echo was reflected.

The direction from which an echo is received is determined by the binaural effect produced by interaural amplitude difference.

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While the ear may, for physical reasons, use interaural time difference and amplitude difference according to the nature of the sound, dichotic presentation of sounds is not so limited and IAD may be used throughout the audible frequency range to good effect. The ultrasonic sensors are so designed that, by suitably splaying them to look slightly left and right, the correct IAD for any individual may be closely approximated.

Thus, built into the binaural system are the means for determining direction, distance, and surface structure of objects in the environment. The effect on the auditory percept cannot be described; it must first be learned through a period of training. Head movement introduces subtleties which require a more detailed discussion than is suitable here.

ACUITY OF PERCEPTION

It must be quite obvious from the great reduction in information which has taken place that the acuity of perception cannot be likened to vision--not even with the greatest stretch of the imagination. Little can be said about this new concept in perception because it has been inadequately researched, but this, however, does not mean that it is inadequately understood for the purpose of evaluation. We all know what an orange tastes like, but we cannot describe this to anyone who has not yet had the pleasure. To the scientist who seeks after knowledge, this may seem to be a weak excuse, but the engineer is not so restricted by his code of practice--to make things work for the benefit of mankind. I must emphasize this difference in philosophy because it has an important bearing on the form of the evaluation.

It can however be stated that the acuity of perception is little different from unaided hearing in determining direction, or in discriminating between two sounds. The accuracy in determining distance can be better than ±10 percent and up to three objects at different ranges *and* directions within the field of view may be resolved by experienced users. This is the absolute limit under stationary conditions. Dynamic conditions seem to add another dimension which so far we have been unable to study adequately, but of course experience under dynamic conditions is now extensive.

Up-down acuity is poor and depends upon movement both of the head and the body.

SPECIFIC TASKS

Several teaching situations give an insight to the capability of the man/machine system. Complex tasks with arrangements of 1 to 2 dozen one-inch diameter poles have been learned by blind users which indicate the acuity of perception when mobile, and one can observe the smoothness of control of the motor system. Each person has to be taught to integrate the new percept with this control system and until this is reasonably well achieved mobility in a real life environment remains difficult and hesitant. Typical tasks are:

1. Walk up to and grasp a one-inch diameter pole from a distance of 12 feet.

2. Walk past a pole at a specified lateral distance, using rate of change of distance and direction to gauge relative positions.

3. Walk parallel to a row of poles at a specified distance.

4. Weave in slalom fashion between poles in a row or a circle.

5. Walk between two parallel rows of poles.

6. Walk through a complex pattern of poles using their juxtaposition for orientation.

7. Place a group of poles in a straight row.

8. Grasp one pole from a group of closely spaced poles.

All these tasks may be taught within one week of training.

OBJECT DISCRIMINATION AND IDENTIFICATION

The following objects are readily recognized in most situations:

Smooth pole
Window
Brick wall
Hedge
Bush
Tree
Parking meter
Parked car
Fencing
Railings
Isolated street sign
Doorway
Up-curb
Traffic islands
Pedestrian moving
Traffic lights
Mail box
Rising steps
Grass verge and smooth path
Overhead branches

This list is an example of objects blind people have frequently said they can recognize in both familiar and unfamiliar situations. The picture of the environment which they construct is less clear and we may never really know what an individual perceives when traveling. Much depends upon the attention at the time, the motivating force, or the complexity of the task being performed. Some merely seek a clear path until the situation demands a knowledge of the environment. We know of no means for monitoring what is perceived, only observing the performance and listening to verbal descriptions. These are always in visual terms but this does not mean that the perception is also in visual terms.

MOBILITY

This is a very complex task requiring skilled teaching in the first instance and an ability to use ambient cues effectively. The perception through the binaural aid has to be integrated with these cues effectively before it can be evaluated by a user or an observer.

Since the acuity of perception is severely limited, a dog guide or a long cane must be used in conjunction with the sensory aid for safety when traveling in an unknown environment. It is customary to refer to the long cane or the dog guide as the primary aid, but this thinking limits the potential of the device which must stand alone in its own right as a sensory aid. Because two aids are now being used simultaneously, there is a natural tendency to refer to the older aid as being primary; but since they play quite different roles, either may be the primary aid according to the situation and the source of attention of the user.

For the purpose of the evaluation, the device is used only in conjunction with the long cane or the dog guide, and this is how it will always be taught; but subsequent usage by a blind person may vary considerably, depending upon his needs and his environment.

The main value of the aid in a *mobility* situation is its ability to warn of objects in the travel path. Where a shoreline exists, this can be followed with ease and landmarks may be located at a distance aiding orientation and navigation. Of secondary importance is the ability to appreciate the environment, but this can give unexpected pleasure. It can neither be observed nor measured, but it may be a prime motivator and as such be very important. There is evidence to suggest this has already occurred.

USER POPULATION

Probably the major reason for having the current evaluation is to determine the user population. It is also going to be the most difficult to determine, and this is discussed under Evaluation. The aims, however, can be stated.

In devising the aid, no thought was given to a particular population other than those blind people who, through limited vision, have problems in going about their daily business. Some have tried to limit the population, usually without good reasons; but obviously the totally blind are in greatest need of an aid.

The criteria determining the range of people who should, hopefully, be able to use the binaural aid are:

1. Normal hearing in the frequency range 250 Hz to 6000 Hz. Special provision can be made for those with a high-frequency hearing loss and some hearing defects may not affect the perception greatly.

2. Physical fitness to travel on foot. There are, however, people highly motivated to travel even though they are multiply handicapped, e.g., amputees, and even those in a wheel chair, who may be aided significantly.

3. Motivation to be independent. There are people who, through lack of appreciation of what can be done, may not be well motivated, so motivation alone should not be a prime requirement. Some who were apparently not motivated or found travel by conventional methods too difficult have become highly motivated by a "vision" of what *may* be achieved with a new sophisticated aid. This should be neither underestimated nor deplored. It should be used judiciously to the advantage of the blind person.

4. So far as it is possible to determine, there is no physical reason why there should be a lower limit to the age of the user. The technology must be greatly improved and careful studies made of the possible side effects, but the possibility of young blind children growing up with the aid poses an irresistible challenge. The upper age limit must be indeterminate; so much depends upon the deterioration of an individual's physical and mental capabilities. The hearing may well be the most serious limitation to use by the older person. People in their 60's should not be automatically eliminated.

5. There is no evidence to indicate that intelligence is an important factor in developing a percept. The use to which this is put may well depend upon intelligence, however. Intelligence cannot be used as a criteria until there is a better definition of it. Tests to predict performance in a task are well known, and special tests may be developed in this field also.

6. While those having total visual loss may receive priority in training, those with partial vision must be considered if they have mobility problems. Hence, the potential user population may be very great and it is predicted that it exceeds the population for the long cane or the dog guide. When statistics of the blind population range between 400,000 and 900,000 in the U.S.A., of whom half may be over 65 and only 10 percent totally blind or have no more than light perception, the possible user population may be between 20,000 and 45,000 persons. Reaching these poses formidable problems.

What of the rest of the world where services for the blind are generally far behind those in the United States, with of course few exceptions? So much is talked about the possible user population, but this is not important when, even with the best will in the world, it cannot be reached in the foreseeable future. More important is the training of teachers, and it is thought this will be more effective in determining policy in relation to a new device than the so-called user population.

THE EVALUATION

DEVICE STATUS

The device has been designed and manufactured at minimal cost because of the risks involved in attempting to introduce it to the blind. A separate paper, already circulated, describes the planning of the evaluation which was concurrent with the development. An aid of this type must be developed concurrently with an evaluation because

it was quickly found that the display was more meaningful when used in real-life situations compared with simulated situations. This is because the information presented is very complex and both memory and *a priori* information play an important part in the perception. The dichotic presentation of simple simulated sounds in a laboratory did not produce a comparable effect although the response to these helped greatly in understanding the mechanisms involved.

While the psychoacoustic tests were proceeding, the device was engineered to give optimal performance using the psychophysical data shown to be relevant.

At no time has it been shown possible to carry out psychoacoustic experiments which would have led to the present device. On the contrary the subjective response to the device signals dominated our approach, and we were forced to make the laboratory tests bear a strong relation to these. This is due to both technological and psychophysical limitations related to gathering the information from the environment and presenting it to the auditory system.

Even at this advanced stage in the development, it is difficult to see how the current program could have evolved in any other way. The device then is as well advanced as was possible within the constraints of the funding made available, and it is sufficiently developed for the risk involved in using it with 200 or more blind people to be small. It was thought unlikely to fail to be acceptable to both blind people and their teachers. This was implicit in my requesting a large evaluation.

The device is not, however, well developed. A great deal of work is still required before we could say no further improvement is possible. There is no reason, however, why blind people should have to wait until this is done. Relatively minor modifications are necessary to insure reliability in service with adequate performance.

TEACHING

Two courses of instruction for teachers were held in New Zealand and Australia prior to the Canterbury Team coming to the United States in March of this year (1971). Two further courses have been held at Boston College and Michigan Rehabilitation Center under the auspices of the University of Western Michigan. A total of 29 orientation and mobility instructors have now been trained.

These courses included learning to use the aid under blindfold with the long cane for a period of up to 40 hours. Most of the teachers reached the advanced business area and demonstrated skill in using the aid/cane combination.

The training courses have constituted a form of evaluation since few instructors would have devoted much time subsequently to training blind people if they were not satisfied that at least the aid had something of value to offer to the blind person. At the time of writing approximately fifty blind persons have been trained and two evaluation reports have been written. One is an individual evaluation by a very competent blind person. The other is a report on the training of twelve guide-dog users and three long-cane users.

At this point in time, we cannot prejudge the outcome of the evaluation, but it is proceeding much as expected, a little behind schedule.

METHOD OF EVALUATION

The proposed evaluation discussed in the circulated paper (Appendix B) was considered in detail during the first course at Boston College in April-May, 1971. Three projects were given to groups of instructors, some of whom were the most experienced orientation and mobility specialists currently in practice. The first project of one week's duration was to determine how to measure mobility using the long cane alone. The second project

was to determine how to measure mobility using both the long cane and the sensory aid. The third project was to test some of the measures devised during the first two projects.

The third project was abandoned after it became evident that the instructors felt that mobility is too complex to measure at present, and those simple measures which have been used in the past and were proposed in the course notes were too inadequate to be of real value. Clearly, without the full cooperation of orientation and mobility specialists, it was pointless to try and gather objective data of the kind proposed. It was agreed, however, that Score Sheet I (Appendix C) would be used.

It was readily agreed that experienced observation of mobility performance would give a more reliable assessment of the capability of the man/machine system. Using nearly thirty instructors, we should get a well-balanced opinion. It was also agreed that where possible film would help in the assessment.

EXPERIENCE TO DATE

The decisions have proved to be correct. It would have been quite impossible and useless to attempt to take objective measures during the training of blind people at this early stage. The instructors have found teaching the sensory aid both challenging and time-consuming requiring high concentration on their part. They could not have taken records.

In addition, almost all the blind people chosen for training have already had long-cane training so the original plan became irrelevant. A new one would have to be devised. Now only those people who have had long-cane training will be used in the evaluation. There are two reasons for this. At the present stage, the instructors feel that in the case of novices the sensory aid will conflict with the teaching of the long-cane techniques. Also, the time taken to teach a novice both the long-cane and the sensory aid will be of the order of sixteen weeks. Using experienced travelers, only four weeks is needed, and the evaluation will therefore not take so long to complete. It can also be said that experienced travelers are likely to be more critical of a new device since they already know what is possible without it.

Technical and administrative problems in all sectors have slowed down the program temporarily, but these have now been reduced considerably, and by November the program should be in full swing again.

POSSIBLE BENEFITS FROM THE SENSORY AID

It is premature to say much at this stage, but some features about the use have now been well established.

The aid does reduce travel stress and the auditory signals do not interfere with the use of ambient cues. Mobility is improved--as observed by the instructors. The sounds are not unpleasant and are often thought to be pleasant and reassuring. The device is cosmetically acceptable and easy to use. It takes about four weeks to train a dog-guide or long-cane user to feel comfortable in an advanced business area. Prolonged learning takes place and so far no one has discarded the device even though the period of use is up to two years for the first person trained.

The questions we have not so far answered are numerous and this evaluation will only answer a few more. We are only just beginning to appreciate the complexity of this new form of perception and the effect this may have on mobility. The teachers seem to be challenged by its potential.

APPENDIX B

LESSON NOTES FOR THE INSTRUCTORS TRAINING COURSE

Probably the most useful dissertation on the evaluation of sensory aids came from John Dupress.[2] In his final analysis there appeared to be only two simple but relevant questions concerning the ultimate worth of a device:

1. Does it facilitate better performance without excessive training, fatigue, stress or injury to the traveler or pedestrian?

2. Does a blind person use a device voluntarily for an extended period after the evaluation is concluded?

These two questions seem basic to any evaluation, but perhaps not included in (1) is the question, "Does the device facilitate mobility in those who could not be mobile by existing means?"

The current evaluation program is designed to answer these questions, but they may not be answered to the satisfaction of everyone. There are essentially five groups of people concerned:

1. The blind
2. The administrators of agencies for the blind
3. The teachers of the blind
4. The behavioral scientist
5. The device designer

To meet the requirements of each group an extensive program of evaluation is necessary and is the reason for the size of the present undertaking. Even so, it may be too limited to do justice to the needs of each section of the interested community.

THE BASIC REASONS FOR EVALUATION

That a device should be evaluated is, today, a universally accepted fact; but few are specific about why. Perhaps it is because each person or group simply wants to be "convinced," but is unable to say what would be convincing. One would expect a major reason for evaluating a device to be the establishment of facts on which to base decisions regarding funds for the purchase and supply to blind people of the device. When agencies are asked to indicate what facts they need the reply is not very helpful. This is understandable because the facts must be related to the specification of the device which very often is not available. The specification must include a statement of what can be achieved, and prior to an evaluation it is unlikely that this information is available, and so we start to chase our tails.

This frustrating circle has been broken for the binaural sensory aid through concurrent planning of the development and evaluation. We are now in a position where we can consider the possibility of meeting the requirements of each interested group who has very different thoughts about evaluation.

THE BLIND PEOPLE

It is natural that each blind person should want to know what there is in the device for him. The only way to find out is to try it. This is personal evaluation

and the answer comes quickly in one of three forms: (a) "No good"; (b) "Interesting and should help those people who are not so capable as I"; (c) "I like it; it helps." For a device to be successfully effective the latter response should be obtained from the majority of blind people not only after short exposure, but also after a considerable period of time and experience.

We have immediately created a problem. Are we to include in the term "blind person" those with some vision--and if so, how much? When we say "the majority of blind people" are we to include the very young and the very old, and what is a "considerable period of time?"

These terms need definition.

THE ADMINISTRATOR

When committing funds their use in one area has to be weighed carefully against the benefits which could have been obtained by their use in another area. Cost-effectiveness is obviously a major factor but probably the most difficult to measure. Effectiveness is the complex factor we would all like to be able to measure; it is even difficult to define. In the case of mobility we are concerned with:

1. The psychological effect mobility has on a person

2. The degree of proficiency reached with the aid compared with that without

3. The increased value of the individual to the community

4. The increased earning potential of the individual

Perhaps (1) is the most important yet it is the most difficult to assess. When asked "Is it worth it?" what information is needed to say "yes?" Statistical data will help to determine the long-term funding required since this is related to a large number of clients but predictors based on personality inventories are also needed to assess the probable value to the individual. In reality of course most administrators will make their judgments based upon experience gained from a trial run within their own establishment whatever may be the data gathered from large-scale evaluations, simply because data is unemotional and impersonal. Administrators are however influenced very heavily by the judgments and decisions of their counterparts elsewhere. So perhaps the individual decisions arising from the several pilot runs inherent in the present evaluation will be of paramount importance in the evaluation.

THE TEACHER

Administrators are going to be influenced greatly by the reports from the orientation and mobility instructor who is responsible for the teaching of blind people. Unless he believes in what he is teaching the end result of his efforts are likely to be "inferior" and the decisions based upon his reports will be suspect. It is very important therefore that each instructor be fully familiar with the device, the method of training, and what can be achieved through its use. This in no way prejudges the evaluation itself; the piano, for example, is known to be a fine instrument, but very few can play it well.

The mobility instructor can therefore be expected to play a major part in the evaluation of a mobility device, and so he must be trained to use the device and teach its use. This involves a course for the instructors and they themselves require a teacher, or teachers, who are adequately knowledgeable in all aspects of the device and its use. Only the research and development team can fill this role initially and their ability to do this will be reflected in the end results.

Evaluation of a device of this kind is therefore dependent upon the ability of a number of people--not only the potential of the device.

The opinion of instructors of the blind will carry considerable weight; in consequence it is important that this opinion be not confined to two or three who could be

biased. A sufficient number must be involved so that a majority opinion has meaning. From the 29 instructors who will be involved in the current program answers to a simple but well-designed questionnaire should produce a meaningful consensus of opinion. This, together with the opinion of the blind person, should help the administrator in his decisions.

THE BEHAVIORAL SCIENTIST

The aim of the behavioral scientist in the present context is to measure performance in executing a skill, and from this design better methods of training. When a device is involved, his task is to determine if it helps significantly in the execution of the skill and suggest ways in which to perform a skill. An *optimum* device should be provided if one is to be used.

Many realize of course that devices germinate from ideas which may not lead to the optimum form. In the absence of any other relevant information however they have to be used. There is of course a body of opinion which believes that an optimum device can only be designed through a basic study of the problem and unless it can be shown that an existing (albeit new) device is performing optimally, the call for a basic study will persist.

During this evaluation an attempt should be made to determine how near the design of the device is to optimum. To do so however we need a definition of the task and a specification for optimum performance. We can then proceed to measure how well this is achieved.

Recent attempts to measure mobility performance[1,3,5] have pointed the way towards a meaningful measurement of mobility skill but do not specify adequately what the skill should be. This is left to opinion. We do not therefore know how far we are from optimum performance when observing a traveler. The use of sighted mobility as the goal has been mentioned, and it would seem that such a goal would be acceptable to all. The introduction of sighted mobility as the upper limit of a rating scale at this present time may seem highly presumptuous and it has so far been avoided; but we do now appear to have reached the stage where we can reasonably use this high rating even if we do not actually approach it.

Since this criterion has never been used before, we are likely to encounter considerable problems in using it, but we do have an opportunity to work these out and perhaps play a part in the further development of new type aids to mobility. Some agreement is needed on where long-cane and dog-guide travel comes on this rating scale when sighted travel is say 100.

THE DEVICE DESIGNER (ENGINEER)

The aid is designed to provide spatial information by audible means, and we need to know just how well this is achieved. Simulated experiments in the laboratory indicate certain limitations, but real life experiences are known to provide information which enhances that from the aid. We cannot at present assess the value of *a priori* information. Until we can determine the limitations of the new form of perception we will not know what improvements are desirable in the device itself, nor will we be able to consider the role of other sensory aids. The evaluation should be such that these measurements can be carried out using the blind subjects, but it must be apparent that only the designers can do this, assisted of course by suitably qualified people who can advise on behavioral experiments and make experimental measurements in this field.

GENERAL COMMENTS

It has been shown that while the behavioral scientist and the engineer can provide information which will be of interest and value to the administrator, the really important person is the mobility instructor supported by the blind person himself. Both must be in favor of using the aid before it can be supplied as an acceptable means to better mobility.

The program has been so designed.

THE DEVELOPMENT AND EVALUATION PLAN

It is not possible to isolate the evaluation process from the development of the binaural sensory aid although it is customary for this to be done in general. Evaluation usually relates to a final product, but in this case many changes are envisaged in the future once it is shown that the basic principle of the device is well-founded. In fact the evaluation has been proceeding for some time past following a plan of development designed in 1966.

The Sonic Torch, which was in fact an early off-shoot of the present device, was developed semi-commercially with the support of agencies for the blind who planned their own evaluation. Its parameters were not studied as they should have been, largely through lack of funds and inadequate facilities, and the method of usage was not explained. It is only recent that objective information about its use as a mobility aid has become available[5] and even this is restricted in value. Quite clearly the development and evaluation of the device left a lot to be desired. This became very obvious at the Sensory Aids Conference in 1966.[4]

The Binaural Sensor was then in a portable experimental form and a study of its design parameters had begun. After the conference, it was evident that if the Binaural Sensor was to be made into a useful and acceptable aid for the blind, significant funding would be necessary and a careful plan of development and evaluation put into operation. The National Research Development Corporation allocated the funds in 1967 and a team of engineers and technicians was formed at the University of Canterbury.

There were two objectives:

1. Study the auditory output of the device to determine the relative significance of the direction cues, and determine the optimum arrangement of the transducers. Other forms of auditory display were to be considered to assess their relative merit.

2. Develop the electronics and transducers to obtain the optimum technical design in terms of performance, cost, size and reproducibility.

When these two objectives were sufficiently advanced psychologists were to have been recruited onto the team with the object of studying the psychoacoustics and training blind people to use the long cane in conjunction with the sensor. It was also planned to compare this combination of aids with the Sonic Torch.

As the device developed it became clear that the study of the auditory output, which was an engineering task, and the psychoacoustics could not be separated, both were part of the development process. The design was gradually changed to improve the performance, and through this process the original concept became more realizable.

This can be simply stated. Through the radiation of ultrasonic waves objects within a cone of approximately 60 degrees and up to a distance of approximately 20 feet produce at the two outputs of the device binaural information indicating:

1. the distance, by the pitch of the sound, and

2. the direction, perceived naturally through the binaural process.

All other features of the device are derived from this basic concept.

By April 1968 the device had reached a stage of development when the training of blind people could be considered. It had by then become evident that an orientation and mobility instructor would be more likely to succeed in training blind people than would a psychologist who had no knowledge of blindness or mobility. By the end of 1968 an orientation and mobility specialist had joined the team.

The engineers had by then established that the device produced the requisite information and through

this one could perceive space by the auditory process. They had in fact evaluated it as a basic engineering system to their satisfaction. What had to be done next was teach others to perceive in the same way and use this percept to aid mobility. The gap between engineers and mobility specialists had to be bridged before much progress could be made.

By August 1969 (ten years after the original concept was formulated) four blindfolded sighted subjects were taught to travel with the assistance of the long cane and the binaural sensor, and the first cosmetically acceptable device was made, using a design of transducer and electronics which were through to be reproducible.

Plans had by then been laid for the training of 20 to 30 blind people on the basis of the results obtained with the four sighted subjects. Funds for this were provided by the New Zealand Foundation for the Blind and The Royal Guide Dogs Association in Australia. Thirty aids were produced as a manufacturing exercise. A second orientation and mobility specialist was recruited onto the team.

The aims of the second stage of what was now becoming an evaluation were simply:

1. Devise a method for training blind people to travel with both the long cane and the sensory aid or the guide dog and the sensory aid.

2. Gain experience from observation of mobility with the sensory aid.

3. Assess the technical reliability of the device and modify the design to eliminate as many defects as possible ready for a major evaluation.

At this point in time the current evaluation program was planned and funding sought. This has now increased the number of mobility specialists involved in the program to 29 and the number of blind people will eventually rise to 250 by the end of 1972.

Even if we were unable to satisfy the requirements of our scientific and engineering colleagues, we will, through the reports of the instructors and the blind subjects, provide the information needed by the administrators of the agencies and the evaluation, by their standards, should be successful.

The cooperation of the instructors however is needed if we are to obtain the scientific and engineering information we need for further development.

OBJECTIVE MEASURES

GENERAL DISCUSSION

Even though the instructor will inevitably express an opinion about the sensory aid based upon observation during the training of his pupils, he should be able to justify this. There should also be some uniformity of views between instructors.

If, for example, one instructor teaches mainly older immobile adventitiously blind people, and another has the task of training congenitally blind teenagers, one would not expect the conclusions drawn by these two instructors to be the same. The basis for the conclusions should however be similar because the task of the blind person is the same whatever the age or cause of blindness.

At this stage we can perhaps hazard a guess about the possible conclusions drawn from these two groups of people--so as to highlight the evaluation problem. It is possible that the older group will be able to reach a higher level of performance with the sensory aid/cane combination than with the long cane alone. We would not expect this to be more than an ability to travel in quiet business areas, and visit friends, social centers, etc., without great stress. The teenager on the other hand is more likely to become outgoing and adventurous exploring the environment in a way that would not be possible without the sensor. They should surpass the skill of the older person at an

early stage in their training and go significantly beyond the level normally reached using the cane alone.

The opinion of the instructor training older people would depend very much upon his knowledge of what could be achieved with the cane and what he expects to be possible with the additional aid of the sensor. He will most probably be influenced by what he thinks the cost benefit should be for this group of people. The trainer handling teenagers will have a more predictable opinion based largely upon the stimulus he must get from his achievement in increasing a young person's mobility.

There is therefore likely to be a wide variation of opinion between instructors training older people; and one can expect a measure of uniformity in the views of those teaching teenagers. When the reasons for these opinions are considered however there should be compatibility. Both will be based upon the observation of performance. Unless there is some objective measure for this there is little chance for fruitful discussion at a later date from which any conflict of views may be resolved. Where high performance was achieved we will want to know what this was and what variation can be expected at this level.

Clearly, there will be a wide variation in the mobility performance of the 250 people who are to be trained and it will be very difficult to assess the validity of individual opinions even with objective measures. Nevertheless, it is still the overall opinion which will count in the long run for it is this which determines the subsequent action. Objective measures, when analyzed, cannot help but exert some influence, however, and they may lead to greater uniformity of action by agencies for the blind.

MEANINGFUL MEASURES

Mobility is a complex dynamic process which is influenced by innumerable factors, many of which are related to the individual's personality and his needs. One highly mobile blind adult recently confessed that he really gained little satisfaction from doing badly what a sighted child of ten finds so easy. The implications of this warrant a little thought. Let us not forget that in evaluating the sensory aid and in training blind people to be mobile we are dealing with individuals, not the "average blind man" who does not exist.

The evaluation by Crause and Leonard of the Client Output of the Midlands Mobility Centre, Birmingham[1] does however show how an analysis of a group of people can be given meaning by dividing them into sub-groups through performance levels. When this is compared with the measurement of mobility of young people at Shrewsbury[3] one finds that the latter analysis completely hides the individual variations because the sub-groups are predetermined. This leaves the reader with little concept of what performance was like.

Even so, the Score Sheets IIa and IIb (Appendix C) of the Shrewsbury Study do provide a means for assessing the performance of the individual in a way which might reduce the variation in the judgment of the observer. This is needed if the method of evaluation used at Birmingham were to be adopted in this exercise. There is of course a great deal in both these studies which is relevant here.

While we seek to evaluate a sensory aid the essence of the present exercise is to determine just how this affects the travel performance of the individual. We should therefore concentrate on this aspect.

The processes of training and evaluation conflict. The former demands attention from the instructor; he is constantly seeking to show his student how to correct faults or mistakes while encouraging and rewarding achievement. This allows no time for the recording of performance measures; the two cannot be done well simultaneously. We are thus faced with obtaining measures after each stage of training is completed; this is the method adopted by Crause and Leonard. They decided upon six levels of achievement in mobility which seem to be highly relevant.

These are:

1. Basic mobility skills
2. Indoor travel
3. Residential travel
4. Local shopping areas, simple bus trips, pedestrian crossings
5. Advanced business areas, bus routes, traffic-light crossings
6. Town center

The basis scores were:

a. The final level (1-6) of achievement reached by the client as judged by the instructor

b. The number of hours spent by each client to reach each level to the satisfaction of the instructor

From a knowledge of the results so far with the cane and the sensory aid combination, it is believed that a significant improvement in performance over that obtained in the Birmingham exercise should be possible. Were this shown to be so, it could be said the measures were meaningful.

The use of Score Sheet IIa would help the instructor to make repeatable judgments on achievement and the variation between individual judgment should be small. The variable in the exercise would be only time to train; performance becoming a constant for each stage. This is an important consideration.

Whatever the aid may do for the individual as an environmental sensor it has little relevance here except where it contributed directly to mobility performance. Where there is value in sensing the environment for its own sake, this can only be judged by the user and his individual opinion is all we can go by. We can however attempt to measure the acuity of perception using the sensory aid but this is a particularly difficult task requiring a detailed knowledge of the device parameters. Only a small specialized team working with a few blind people is likely to succeed in this part of the exercise. The Canterbury Team hope to be largely preoccupied in this direction.

PROPOSED OBJECTIVE MOBILITY MEASURES

If people are going to vary in their mobility performance, this is most likely to be in level of achievement rather than how well a specific task is executed. There will of course be variation in travel performance between subjects in any given type of area, but if travel is to be regular and maintained over a period of time it must be above a critical minimum level. This will tend to be smooth and relaxed travel for the majority in the group. If it were below the minimum level there will be a tendency for the travel ability to decline and probably cease.

The time taken to reach each level of performance should therefore be used in this evaluation exercise.

Score sheets are provided.

Score Sheet I (Appendix C) is to be used to indicate when each task in the controlled area lessons 1-3 has been executed satisfactorily.* It is not expected that all subjects will do all the exercises but each exercise completed should be ticked off.

With Score Sheet I are two charts; one is to be used to indicate the accuracy of localization. The other is to be used to show how well a subject is able to grasp a pole.

The complex pole exercises are to be scored where used.

Score Sheets II a-b (Appendix C) are to be used for each of five stages.

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*Controlled Environment Exercises 1, 2, and 3 are described in Appendix C and some photographs of these exercises are also shown.

Stage I - Residential
Stage II - Built up area (industrial)
Stage III - Pre-business area
Stage IV - Advanced business area
Stage V - Drop off

Each Score Sheet should be constructed for the route and a large scale map of the route is to be returned with the score sheets.

A film record should be taken of the routes and two subjects are to be filmed traveling these. This will make possible a comparison of performance scores from each center and some scaling can then be done before final analysis.

Each instructor will complete a questionnaire at the end of the exercise and the results will be analyzed to obtain an "average opinion."

Each blind person will complete a questionnaire too, from which a consensus of opinion may be obtained. The personality profiles will be compared with the results of the questionnaire to determine correlations.

Predictors will be obtained from the analysis of the score sheets and the personality profiles.

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1. Crause, R. J., and J. A. Leonard. *Client Output Evaluation of the Midlands Mobility Centre*, Department of Psychology, University of Nottingham, 1970.

2. Dupress, John. "Sensory Aids Evaluation--Procedures and Instrumentation," *Sensory Devices for the Blind*. St. Dunstan's, 1966, p. 3.

3. Leonard, J. A., and R. J. Wycherley. "Towards the Measurement of Performance of Travel Skill." *Proceedings of Conference for Mobility Trainers and Technologists*. M.I.T., 1967.

4. *Proceedings of the International Conference on Sensory Devices for the Blind*. St. Dunstan's, London, 1966.

5. Sharpe, R. *The Evaluation of the St. Dunstan's Manual of Instruction for the Kay Sonic Aid*. Department of Psychology, University of Nottingham, 1969.

APPENDIX C

LOCALIZATION TRAINING

Objective:

To teach the direction cue and correct for distortion of "field of view."

Procedure:

Part I	Use protractor painted on ground as per diagram. (Figure 2.)
Stand subject at center of curvature marked "0" facing towards 12 o'clock.
Place 1" diameter pole in position according to evaluation chart for first test.
Tap pole with stick and ask subject to point with cane at the pole. Record direction indicated with No. of Test.
Move pole to next position and repeat.

Part II	Repeat pole positions but do not record.
Subject to point to pole then be guided to "touch" position with cane as required (i.e. swing "left" or "right").
Note consistent errors.

Part III	Subject to stand at point "0" with aid "off."
Place pole in position according to evaluation chart.
Subject to switch on aid but *not* move head.
Ask subject to point to pole with cane but not swing it in an arc.
Record direction of pointer by inserting No. of Test.
Repeat for all positions switching aid off during repositioning of the pole.

Part IV	Repeat Part II but do not record direction.
Subject to point at pole then be guided to touch position as required.
Note consistent errors.

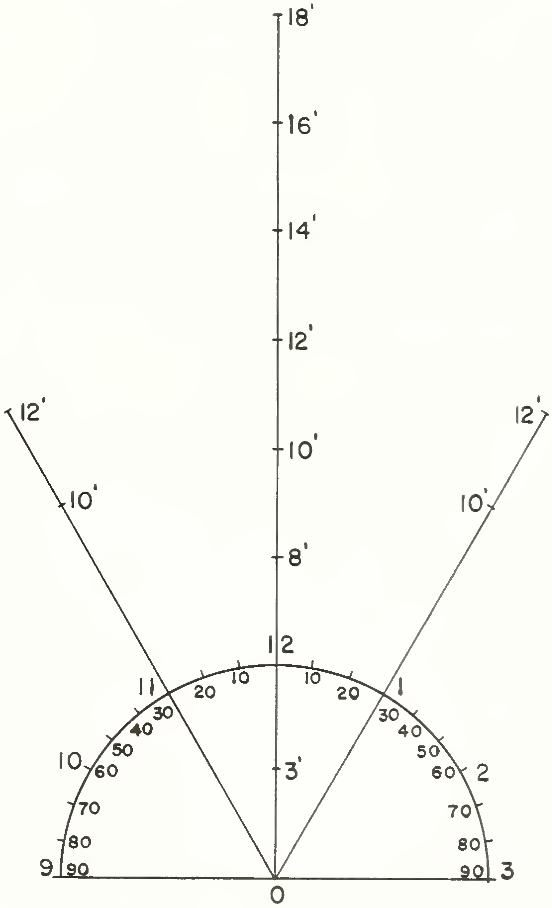


Figure 2. Protractor Painted on Ground for Field Test of Localization

Observations:

The subject is given feedback during Parts II and IV so as to correct for errors.

If distortion of the field of view persists, the splay angle or the internal volume settings are to be adjusted to correct for this--to be carried out under supervision until proficient.

EVALUATION OF LOCALIZATION

Objective:

To assess directional accuracy.

Procedure:

Use protractor painted on ground as per diagram.

Stand subject at center of curvature marked "0" facing towards 12 o'clock; the aid to be switched "off."

Place 1" diameter pole in position according to evaluation chart for first test.

Switch on aid--subject must not move head.

Subject to point with cane to position of pole. The cane must not be swung in an arc after pointing.

Record direction of pointing on chart (Figure 3) inserting the No. of Test (e.g. "9") in direction indicated by subject.

NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
POLE POSITION	+10	-20	-30	0	+30	-10	+10	+20	-30	-10	0	-20	+30	+20
NO.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
POLE POSITION	0	+10	-30	0	-20	+10	+30	-30	-10	-10	-20	+20	-30	+20

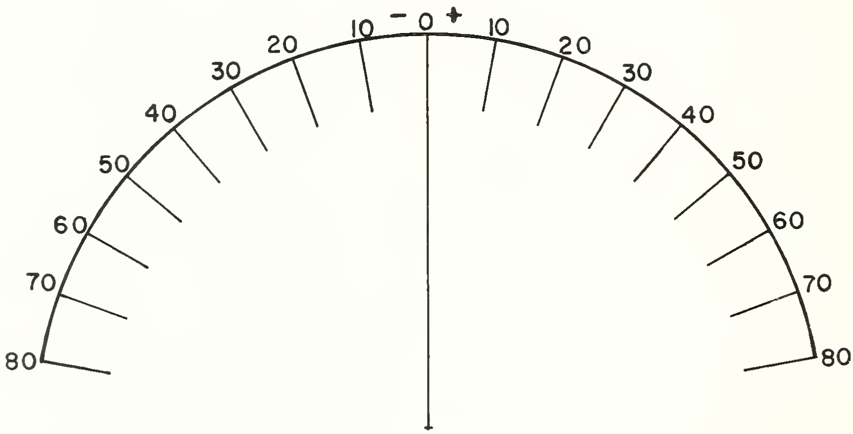


Figure 3. Direction Training Score Chart. Mark direction for each judgment

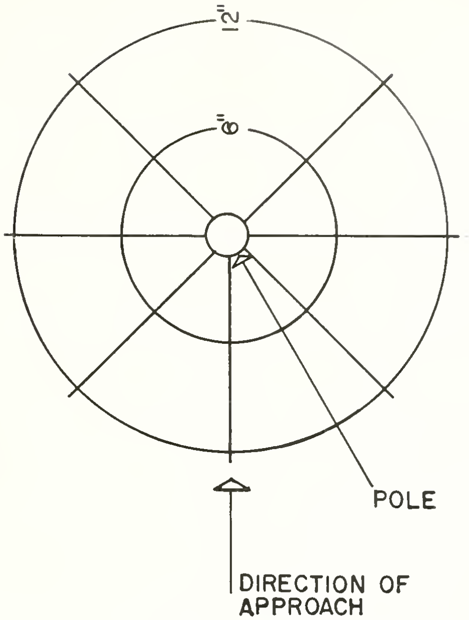


Figure 4. Score Chart for Grasping Pole
Mark position of hand for each attempt with "No." of attempt, e.g. (7)

Score Sheet I

Binaural Aid Evaluation 1971-72

Center........................

Observer........................... Subject..........................

Sex..............................

Degree of Vision................... Date of Birth....................

Onset .... Hrs. of Training................

Other Impairment ....

	a	b	c	d	e	f	g	h	i	j	k
Lesson 1 Perpendicular											
Lesson 2 Parallel											
Lesson 3 Combination											
Complex Pole Tasks											

Score Sheet IIa

Binaural Aid Evaluation 1971-72

Center.........................

Stage.........................

Observer.........................

Subject's Name...................

Sex.............................

Degree of Vision................

Date of Birth....................

Onset...........................

Hrs. of Training.................

Other Impairment................

Time for Course..................

Section of Test Route	crossings	up curbs	indentation correction	correct path	position	bump wall off curb	obstacles	detours	indentation	down curb	square up	listen	mobility grade	time over section

Score Sheet IIb

Binaural Aid Evaluation 1971-72

Center.........................

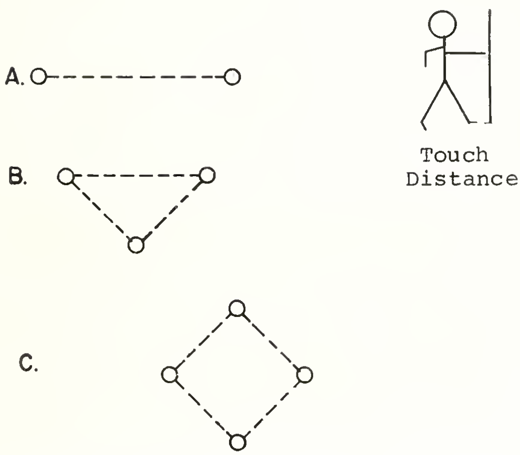
Stage.........................

Subject's Name...............

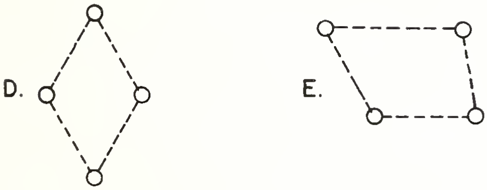
		Assessment						
1.	Pavement Position	: Mid	( )	Wall	( )	Curb	( )
2.	Downcurb Detected	: Anticip.	( )	Cane	( )	Falls	( )
3.	Square on Curb	: Yes	( )			No	( )
4.	Listens Before Crossing	: Yes	( )			No	( )
5.	Crosses	: Straight	( )			Veers	( )
6.	Corrects Veer	: Yes				No	( )
7.	Upcurb Detected	: Anticip.	( )	Cane	( )	Falls	( )
8.	Upcurb Drill	: Yes	( )			No	( )
9.	Indentation	: Yes	( )			No	( )
10.	Indent Correction	: Yes	( )			No	( )
	<u>Obstacles Detected</u>						
11.	Audit	: Yes	( )			No	( )
12.	Tact	: Yes	( )			No	( )
13.	Obstacles Detoured	: Yes	( )			No	( )
14.	Travels Straight	: Yes	( )			No	( )
15.	Bumps Walls	: Yes	( )			No	( )
16.	Falls off Curbs	: Yes	( )			No	( )

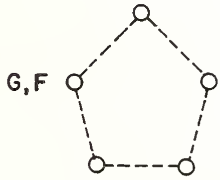
General Comment:...
....

Lesson 1 - Perpendicular exercises (poles)



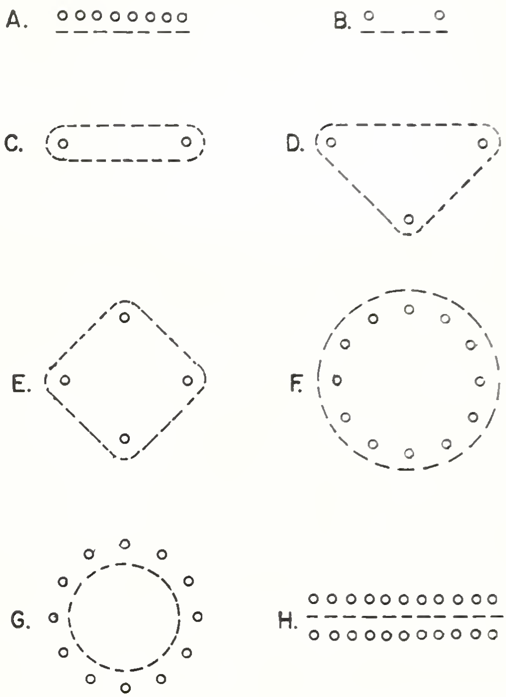
May procced to:



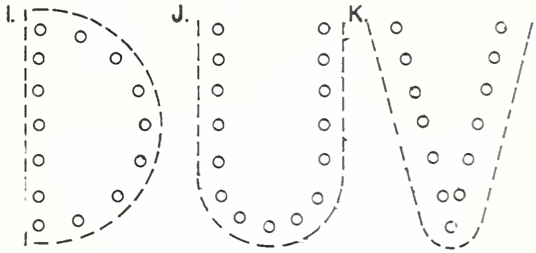


May place trainee in center of pattern and have him identify shape by location and pitch relationships of signals.

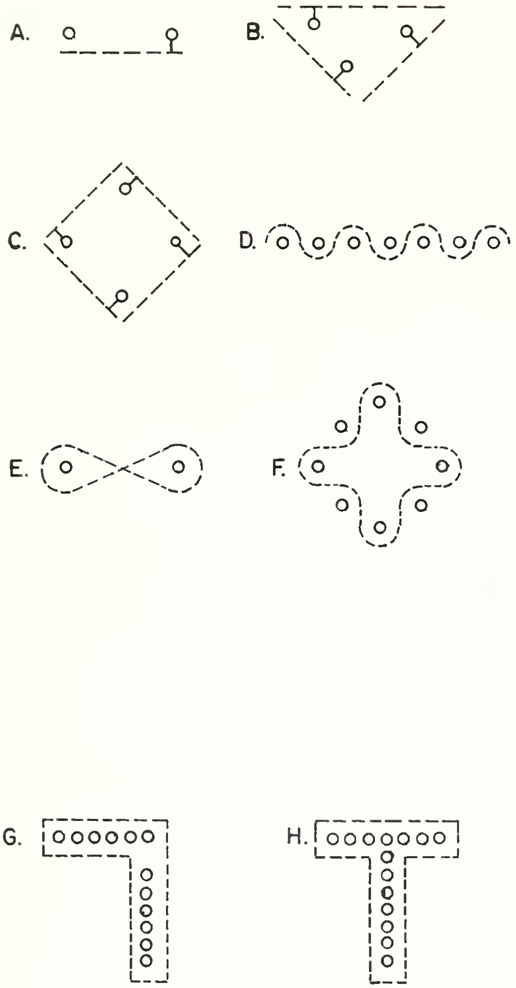
Lesson 2 - Parallel exercises (poles)



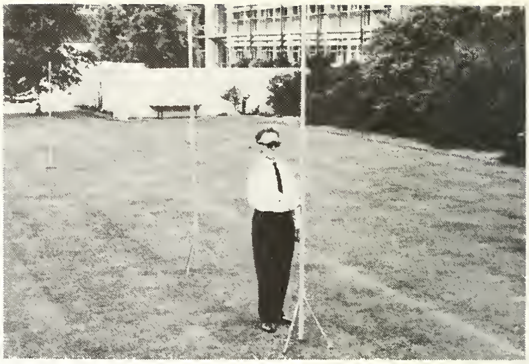
May procced to:



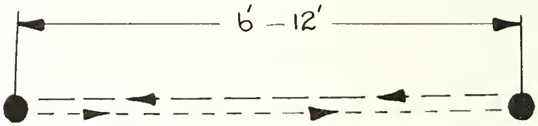
Lesson 3 - Combination parallel, perpendicular exercises (poles)

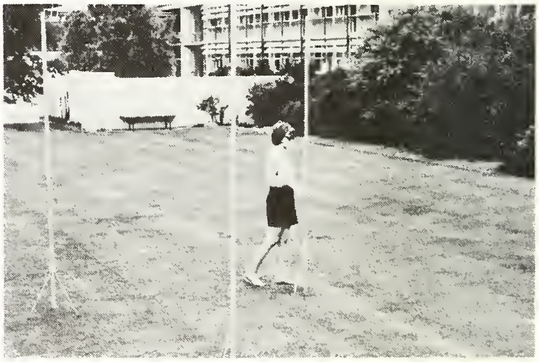


Note: Succeeding lessons will utilize Sonic Aid initially, latter portion of lesson, both Sonic Aid and Long Cane. The dual approach is thought to facilitate smooth combination of the cane/aid system while providing basic sonic learning experiences in the controlled environment.

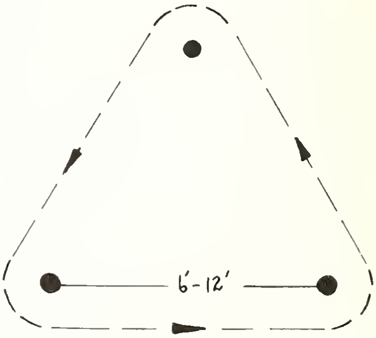


Walking between two poles and grasping them. (Perpendicular exercise Lesson 1a)

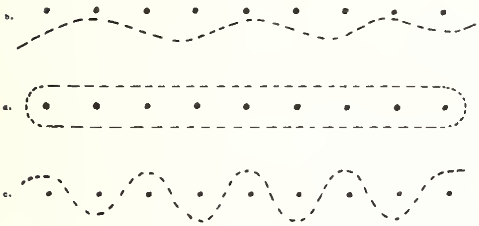




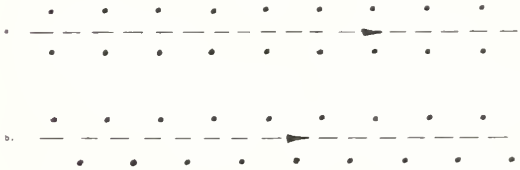
Walking round three poles (combination of perpendicular and parallel exercise Lesson 3b)

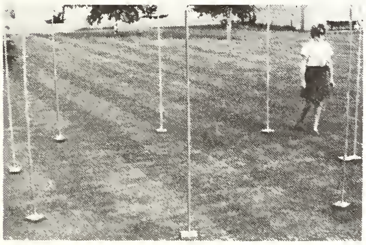


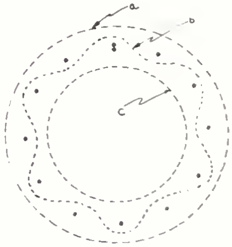
Walking along a row of poles
(Lesson 2a and Lesson 3d)



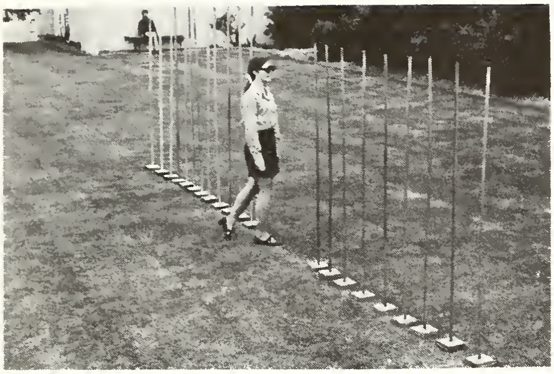
Walking along two rows of poles
(Lesson 2h)

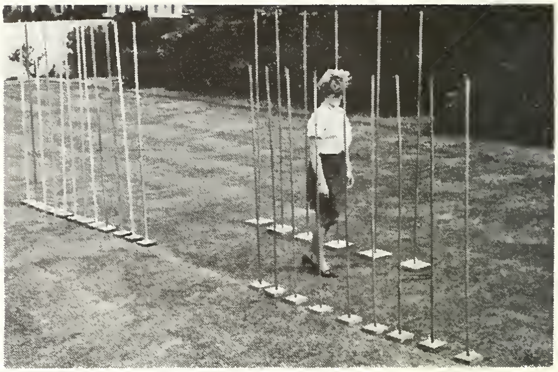






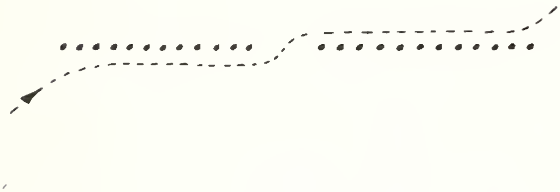
Walking round a ring of poles (Lesson 2f and 2g and Lesson 3f)

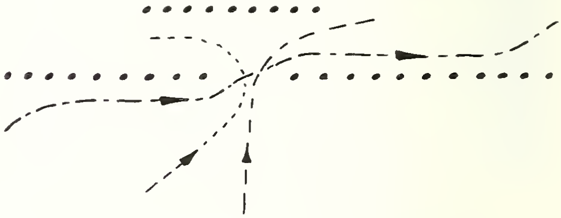




Finding gap in "wall" of poles.
Complex pole task.

Walking in complex pattern of poles.





DISTRESSFUL LIFE SITUATIONS AND THE EMOTIONAL STRAIN FELT BY SUBJECTS WITH SEVERE VISUAL DEFECTS*

Oldrich Calek**

SUBJECTS

Eleven subjects (seven male and four female) were used in this study. All of them studied at the Secondary Music College for Youth with Visual Defects in Prague, Czechoslovakia, at the time of this study in 1970. All of them were between the ages of 18 and 20. All of them fell in the lowest category in the classification of visual impairment; this meant that they were all, to all practical intents, totally blind. All of them were "naive" from the psychological point of view. This means that none of them had previously passed any psychological, or psychiatric examination, or exploration. The subjects selected for this study cannot be taken as a representative sample of all totally-blind people. They make up a special group of subjects--those who are prospective music teachers. Their professional careers are already oriented around their special artistic abilities.

METHODS

The leading methodological principle of this work can be given by the use of the technical term *case study*. It does not mean that other kinds of methods were not used as well. On the contrary, several other methods were used such as psychological test methods adapted for visually-impaired subjects. There were five verbal subtests used from the Wechsler-Bellevue Adult Intelligence Scale. Both versions of the Eysenck Personality Inventory were used, as well as both forms of the Cattell Anxiety Questionnaire. In addition, a special Czechoslovak questionnaire of neuroticism prepared by Professor Knobloch called "K N 5," stressing the somatic basis of neuroticism, was used.

The selection of the questionnaire methods stressing neuroticism was based on the generally accepted assumption concerning the relation between behavior in stressful situations and neuroticism.

Two projective techniques were used: the Rosenzweig's Picture Frustration Study adapted for use with visually-impaired subjects by the author, and another projective method was used adapted from this by the author. It will be called the Frustration Technique for the Blind.

Clinical interview of a rather intentionally directed kind was at the center of all the methods used in this study. An inventory of topics was prepared for the interview. These topics were selected in such a way that they covered all the possible stressful regions in the life of the visually-impaired person as revealed in the preliminary interviews.

The level of emotional strain was evaluated according to the complex criteria laid upon the verbal

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*This paper contains all the essential arguments in an unpublished dissertation presented to the University in partial fulfillment for the requirement of Doctor of Philosophy. This study is based on case studies of the psychological situation of eleven visually-impaired adolescents.

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responses of the subjects to the different topics of the interview. The whole interview was tape recorded. The topics were discussed by the author with the subjects in three different sessions.

TERMINOLOGY

The basic terms used in this study were adapted from the book by J. Cap and Z. Dytrych, entitled, *Conflict, Frustration, and Stress in Relation to Personality Formation*, published by S. P. N., Prague, 1967. Stressful life situations are, according to these authors, those situations where the satiation of any need is combined with any kind of obstacle, trouble, or complication. Stressful situations, as well as frustration and conflict situations, may be taken as examples of these stressful life situations. There are mild differences between them. The need given is satiated to a certain minimum level in the stressful situation even when its satiation is combined with certain difficulties. The satiation of a certain need is totally blocked in the frustration situation. It is possible to call these situations by other names, deprivation, blocking the satiation of a certain need, spoiling it by a certain conflict, etc.

SUBJECTIVE EVALUATION OF THEIR SITUATION BY VISUALLY-HANDICAPPED INDIVIDUALS

There were two questions given to each subject in this study pertaining to the description and evaluation of their total situation. The first was, "Are there any disadvantages in the life of the visually-impaired individual when his life is compared with the life of those whose vision is normal?" Let us look at the answers of the subjects.

All subjects acknowledged the existence of some disadvantages in their lives when compared with those of people with normal vision. There were different kinds of these disadvantages given as examples: dependence on other people; restriction of a full cultural life; impossibility of perceiving the plastic arts; restriction in possibilities in the selection of a profession; restriction of an allocation of free time and interest activities, hobbies, etc.; the need to live for too long a time in a collective dormitory of a hostel type; difficulties in space orientation; the impossibility of normal reading of inkprint printing; the nonexistence of visual feedback for one's own movements; difficulties of coming into personal contact with other people, especially with those of the opposite sex; difficulties in nonverbal communication in the restricted perception of the mimic and gestic; inability to drive a car; difficulties in closing ties of friendship with visually-normal people, and in the socialization process when entering their groups; difficulties in free movement in the natural environment; absence of certain visual images and ideas common to other people; difficulties in the use of public transport; difficulties when moving in traffic; difficulties met in dancing as normal people do; the difficulty encountered in following the story line in the cinema; difficulties, especially with girls, that are encountered in keeping pace with fashion, etc.

The second question was, "What is the visually-handicapped individual robbed of (if at all) in comparison with visually-normal persons?" There was not as good an agreement in answers to the second question as in answers to the first. It was possible to find a certain unanimous law in answers to the first question: restrictions laid on the selection of professional and interest activities, difficulties in space perception, and an inability to read inkprint, were among the most often and perhaps generally mentioned troubles and disadvantages of the visually-impaired. But there was not in the least a unanimity in answering the second question. A majority of six subjects revealed a kind of impoverishment due to their visual defect. Three other subjects thought that the relative impoverishment is fully compensated by enrichment in other spheres due to, for example, the sharpening of other senses, and to the more sensitive perception in other respects. The last two subjects did not think that the visually-

handicapped person is impoverished at all. They tried to show the difference between a culturally very sensitive and educated visually-normal individual, on the one hand, and the visually normal, but culturally-backward individual, on the other hand. They showed as well the positive value of social care that they can see in their own personal experience.

Reviewing these answers we can come to the following conclusion: The objectively very difficult disability ensuing from a severe visual impairment and the situations caused and produced by it, may be subjectively evaluated and emotionally experienced in very different ways.

SCALING DIFFERENT KINDS OF STRESSFUL SITUATIONS

In reviewing the differing stressful situations, we tried nonetheless among their diversity to synthesize the image we got from our study. We tried to see some regularity in their causation of emotional strain. We asked ourselves; "Which are the situations that can be more generally called stressful, bringing strain to those with a severe visual defect?" Analyzing the answers to our question pertaining to the general conditions of life of a visually-handicapped individual, we came to the following conclusion: The reason most often given by our subjects (i.e., by ten out of eleven subjects) for personal strain was the inability to achieve success in many activities at which visually-normal people succeed. Several professional, sport, and artistic activities were mentioned here. Seven persons spoke of a painful relative impoverishment in the perception of outer stimuli. They thought that their lives could be richer if they could see colorful scenery and the products of the plastic arts. Six persons stressed difficulties in receiving information that they would like to get from the environment. Five persons mentioned monotony as the result of this impoverishment and deficiency in visual stimuli. Five persons indicated the slow and unskilled ways of living and manipulating objects arising out of their visual deficiency as the main source of emotional strain. Five persons expressed regret for the lack of the possibility of nonverbal communication. Three persons knew from their personal experience the meaning of a severe kind of psychic deprivation in childhood.

FREE TIME ACTIVITIES

Nine subjects in our group mentioned a wish to have a hobby that they cannot have because of their visual impairment. Nine persons out of eleven wanted to participate in a sport activity they cannot pursue due to their visual defect. Swimming was the most wished-for kind of sport mentioned. Nevertheless, six persons revealed that they have some physical trouble with body movement and physical fitness. Four subjects revealed sorrow that they are restricted in their movements because of their visual deficiencies. Seven persons expressed sadness that they could not fully enjoy living in a free and natural environment. Six persons were troubled by an inability to dance, especially where modern dances are concerned. Five persons felt distress when they were not able to participate in artistic activity. Plastic arts were most often mentioned as not accessible to them. Four persons said they were sorry not to see, and in this way to participate in a passive way in enjoying the plastic arts. Two subjects said their deficiency lowered their capacity and their ability to improve in their hobby activities.

SELECTION OF A PROFESSION

Eight subjects felt some distress in the selection of a profession. They thought that they participated passively in the selection process. They had, according to their answers, no other chance but to take what was given them. Seven persons were aware of some of the troubles they will have to face in carrying out their professional work as teachers of music. Three persons felt their vocational training was really very strenuous. They thought that they would not have the requisite ability they must have for the profession they are being trained for. They felt a certain lack of

musical endowment. (There were only two persons totally dissatisfied with their general achievement level in professional training.)

ANTICIPATION OF VOCATIONAL INTERPERSONAL RELATIONS

Eight persons were really afraid of the encounter with prospective superiors. They anticipated distrust and underestimation of their ability by supervisors because of a visual deficiency. Eight persons were aware of some difficulties in their interpersonal relations with professional peers. They anticipated being overlooked for promotion, apathy toward them, etc. Six persons indicated distress in thinking about encounters with pupils in the future. They were already aware of the lack of diligence of some prospective pupils, of some varieties of cheating and deceiving teachers, and that they would be sensitive to unfair jokes at their expense. Nine persons were afraid of troubles they would have to face when communicating with the parents of their pupils.

STRAINS IN ENCOUNTERING VISUALLY-NORMAL PERSONS

Ten subjects out of eleven we studied mentioned differing stress elements they see and can feel in the behavior of visually-normal persons. To be able to diagnose what is really stressful in the behavior of other visually-normal people we used the following procedure. At first we reviewed different stressful situations. This review was undertaken as a result of a pilot study. The stressful situations were presented to subjects in pairs. Two analogous, but to a certain degree different, situations were paired each time. It was the task of the subject to reveal distress he felt in this or that situation mentioned in the pair. The results are given in the following section. The number of subjects who mentioned that situation as stressful is indicated in parenthesis. The subjects evaluated only those situations which they had encountered in their own lives.

PAIRED COMPARISON OF STRESS SITUATIONS

1. Overestimation of some abilities of visually-impaired people (5) vs. underestimation of their abilities (8).

2. Pessimistic attitude toward the possibilities for the visually-impaired (2) vs. appeasement of blind people (6).

3. Pity and compassion (6) vs. offensiveness and mockery (2).

4. Apathy and disinterest (1) vs. obtrusion and assailing with questions (7).

5. Unreadiness to help when help was badly needed (4) vs. assailing with unwanted help (6).

6. Restricted contact with others (4) vs. feeling of loss of privacy (3).

7. The visually-normal who rejects payment for services rendered to visually-impaired people (1) vs. the contrary wish for recognition, and greed, by the visually-normal (3).

8. Disrespect by the visually-normal for the visually-impaired person (3) vs. asking others for respect to be rendered to visually-impaired persons in an unsuitable or unfair way (5).

9. The distress felt in situations in which the visually-impaired person has to ask other people for help (4) vs. the situation when these persons have to reject unwanted help (1).

10. Total uninterest in the social environment in their needs (2) vs. situations in which the visually-impaired person becomes the center of interest for other people (8).

11. Situations in which visually-impaired persons have restriction in possibilities of engaging in public activities (3) vs. situations in which they have to participate in public activities (4).

12. Physical solitude (3) vs. being among other people (4).

13. Humanitarian behavior directed toward the visually-impaired person (1) vs. asocial behavior directed toward them (1).

There were only two subjects who expressed a feeling of distress when in contact with other, visually-normal people. Generally speaking, eight out of our eleven subjects disagreed with the attitudes held by the visually-normal toward them, and with their evaluation of the life situation of the visually-impaired person.

RESPONDENTS' ATTITUDE TOWARD THEIR OWN PERSONALITY AND SOCIAL CHARACTERISTICS

Another group of questions pertained to the attitudes of the visually-impaired persons toward their own personality profile, and to their social relationships. Nine persons indicated that they were not satisfied with certain traits in their personalities, or with some characteristics of their social behavior. Eight said that there was a certain strain for them in situations in which they had to make a decision either in a time stress or in a high-risk situation. Seven persons felt a certain personal discomfort in depending on the outer world. Seven persons considered the conditions they have for their selfrealization as totally insufficient. Seven persons had some trouble with their existential problems, of the "raison d'etre" type. They revealed in addition the presence of troublesome feelings of being "good for nothing." Six persons indicated a certain frustration of their aspiration to achieve. Only five persons named explicitly their visual impairment as the reason for their inner troubles.

FAMILY RELATIONSHIPS

Nine subjects lived separated from their families for a certain time during their childhood. For six of them it meant a really difficult time emotionally, a time whose negative influence remains to the present. Five subjects revealed negative feelings toward their mothers' attitudes toward their visual defects. Their mothers felt guilt for their childrens' difficulties and this put an emotional strain on their children. Five subjects mentioned certain feelings of discomfort arising from the attitude of distant relatives toward them as visually-impaired individuals. Other situations revealed by the subjects as a cause of emotional strain arising out of family relationships were of a rather individual sort. It is, therefore, difficult to generalize, but this does not mean that these situations do not play an important part in the individual's life history. The contrary may be said to be the case.

SEXUAL AND EROTIC RELATIONSHIPS

Four persons in the group revealed some negative feelings relating to the rarity of occasions for coming into sexual and erotic relations with others. On the contrary, there were only three subjects totally satisfied with their current sexual and erotic activities. Five persons had already survived one sexual disillusionment in their lives. Three of them showed a deep disappointment in, and a frustration of, a good sexual and erotic relationship at just the time of our study. The majority of the subjects studied revealed the negative influence of parents, friends, educational staff people, etc. in their sexual and erotic affairs and relationships. Nevertheless, only four of these subjects took this influence to be the cause of any real emotional strain. Four subjects named their visual impairment as the main cause for the sexual and erotic troubles they had. Two subjects indicated regret that their visual defect was an obstacle in their prospective marriage plans. Seven subjects anticipated difficulties that they would encounter in their prospective marriages directly as a result of their visual impairments. Five subjects expressed fear of the hereditary nature of their visual impairment.

RECOLLECTIONS OF RESIDENTIAL SCHOOL

Five subjects lived for a period of several years in a residential school. Three of them took it then, and take it now to be a very negative period in their life histories. All five persons revealed negative memories of their teachers, especially concerning emotional frustration, inappropriately strict orders, and discipline in the residential school.

THE SCHOOL

"The school" means a state institute in our country. It was not possible to find any particular strain indicating a general trait in the recollection of our subjects relative to elementary school and especially to the educational procedure. As for secondary school, seven subjects gave us information concerning the existence of strain, especially during entrance examinations for this phase of their educational careers. Four subjects expressed dissatisfaction with the attitude of visually-normal educational staff people towards them, and to their visually-impaired friends. Nine subjects mentioned a certain level of dissatisfaction with the attitudes of their fellow students who are not so visually-impaired as themselves. By this is meant a certain social conflict between the totally blind and partially sighted.

THE HOSTEL

Seven out of our eleven subjects viewed living in a hostel of the Secondary Music School negatively. Separation from parents, inappropriately strict discipline, etc. were given as grounds for this view. Nine persons viewed the behavior of educational staff people in the hostel of the elementary school for the visually impaired as a clearly negative mode of human behavior in a social context. Only five persons indicated finding dissatisfaction with similar modes of behavior of similar kinds of people in the hostel of the secondary school. (Author's remark. We are sorry to say that leaving out the actual answers of our subjects negatively influenced this review. If we gave verbatim answers of our subjects it might be more interesting but it would unduly lengthen this paper.)

SENSITIVITY TO SOCIAL ASPECTS OF STRESS SITUATIONS

T. D. Cutsforth, in his book, *The Blind in School and Society*, 1933, pointed out that the frustration endured by the visually impaired in contact with the physical environment is most often founded in the emotional strain arising from the social sphere. The conflict between norms of social behavior and the need for selfregard of the visually-impaired person has to be seen as imbedded in this background. We have found this to be the case in our study. It was possible to discover as in our discussion topic labeled, "General Conditions of the Activity of Visually-Impaired Subjects," or, "Self-Service of the Blind Individual." We discovered it as well in the answers to questions in the projective tests, the Picture Frustration Scale adapted from Rosenzweig for the visually impaired, or in the author's version of a similar procedure mentioned above.

Nine subjects stressed the social aspect of their accidents and physical collisions with obstacles in their path on the street. They expressed shame for such accidents in facing the visually-normal person. This feeling of shame and emotional strain was for them more stressful than the physical encounter and pain from a collision accident. Five subjects mentioned the unhappiness arising from failures in person identification. Encountering people they could not precisely identify embarrassed them. The feeling was worse than the frustration of a need for information itself. Seven subjects expressed a feeling of real strain arising from the social aspects of eating. They were distressed to sit at a table with people they did not know very well and to be seen eating by others. They indicated that very often they would rather give up even a very desirable meal when eating it is connected for some of them with really difficult

technical tasks, rather than to try to manage to negotiate it and risk failure in a social situation. Nine subjects mentioned an arousal of shame when any visually-normal person mentioned any defects in their attire, or incorrectness in their appearance.

It was possible to discover this kind of strain even when the visually-impaired person used public transport. It arose in situations where, for example, they entered a tram or bus and a visually-normal person expressed sorrow for them and showed this in a way that offended them. Verbal comments of others really imposed a strain. Our subjects expressed preference for personal discomfort rather than this kind of recognition for their impairment.

OTHER ASPECTS OF THE REACTIVITY OF THE VISUALLY IMPAIRED

We base our discussion of other aspects of the behavior and feelings of the visually impaired on the results of an analysis of psychological projective techniques. Using Rosenzweig's terminology common in the Picture Frustration Study we can conclude that one-half of the answers of our subjects can be regarded as extrapunitive orientation of their aggressivity. The other half of their answers can be divided equally between intropunitive and impunitive orientation. If we take the type of reaction into consideration, the majority (59 percent) of the answers can be classified as a variety of *ego defense*, next is *need persistence* (23 percent), and the rest can be labeled as an *obstacle dominance* orientation. The most used factor in this evaluation was that labeled *E* which appeared in one-third of all the responses. Following this comes the factor *M* (13 percent) and factor *I* (11 percent). According to Rosenzweig these factors have to be regarded as the most decisive characteristics of our subjects.

Using our own adaptation of Rosenzweig's Picture Frustration Techniques we came to the same kind of conclusions. Fifty percent of the responses of our subjects could be classified as extrapunitive. With our adapted method impunitive responses rose to 30 percent. Intropunitive responses were given rarely. When the results of both techniques are considered we can safely conclude that the results are comparable. This does not pertain, however, to the intra-individual situation. There were some four cases in which the order of frequency of the different kinds of responses were not quite the same for both techniques; but taking the whole group into consideration, the equal distribution of responses holds.

PROBLEMS OF MALADAPTATION OF THE VISUALLY IMPAIRED IN FACING STRESS SITUATIONS

It must be emphasized that learning is the normal way of acquiring skill in solving stress situations. Reinforcement plays an important role here. Taking reinforcement to be the main factor in learning to cope with stress situations, we see that it can be responsible not only for acquisition of adaptive ways of coping with life situations, but is as well a factor in the acquisition of maladaptive responses and ways of solving stress situations. The later case results when a temporary relief and lowering of emotional tension is achieved as a certain type of reinforcement is combined with an unrealistic mode of reacting or solving a problem situation. E. Wolf in his unpublished habilitation work entitled, *Psychogenic Disorders*, Charles University, Prague, 1963, looks at the establishment of such maladaptive skills from the interpersonal and reflexologic point of view. He sees a really short time character in these maladaptive skills and modes of solving stress situations. Their persistence is made possible, according to Wolf, by their social reinforcement. Social approval has to come not only ex post facto as a reinforcement of what has already occurred, but it may itself form a maladaptive mode of behavior. This means that the individual conforms in a way complementary to the demands of his social environment, to social conditions, to expectations aroused by it--and is reinforced for the behavior if

he conforms. Differing kinds of attitudes, dispositions, and anticipations are the result of this social reinforcement process. The individual takes them with him into relatively new social environments as he moves. It may be that a new social environment responds in a manner positive and complementary to his already acquired modes of behavior. If it does it reinforces in this way the now already formed anticipations, skills, and forms of problem solving in differing kinds of stress situations. The family is the primary locus in which differing techniques of coping with stress situations are formed, according to the majority of present psychological theories.

It is possible to apply this theoretical point of view as well to the behavior of visually-impaired individuals, in our opinion, and to the formation of their skills, anticipations, and dispositions. The situation with them is a bit more complicated when it is compared with that of visually-normal people. Dispositions of a visually-normal and well-adapted person who is neurotically maladapted are not inborn. They were formed during a certain time in his life history and may be reversed by the influence of interpersonal corrective psychotherapy. The visually-impaired individual, on the other hand, is influenced by an irreversible cause. He takes it with him intact to all situations and environments. His impairment is the source of a certain behavior, disposition, and attitude in any environment he encounters. He has but to adapt to it in a complementary way. He very often acquires a certain kind of neurotic behavior in this way that injures him, but it is in accordance with the expectations of his social environment.

Other visually-normal people take the visually-impaired person, unrealistically, to be a really and totally disabled individual. Not conforming to this general expectation, to this image that the visually normal have of the visually-impaired individual may be to risk being taken for a foolish creature, or in the best possible case for a man who is not educated in "decent" ways of social behavior, and therefore does not know how to behave. The ways of behaving that are taken as normal and adaptive by visually-normal persons in their environment may be basically wrong and not in the least normal and adaptive. The same may be said about contrary kinds of behavior; about the abnormal ways of behavior of the blind.

It is possible to demonstrate this theory in analyzing many of our case studies. The life history of many of our subjects enables us to understand a little better their present modes of coping with the stress situations they meet. This kind of analysis was done at length in considering case histories of our subjects in the original dissertation from which this paper has been drawn. It could also be demonstrated with the use of questionnaire data mentioned in the first part of this paper.

THE WORK OF A PSYCHOLOGIST AMONG THE BLIND

In the original dissertation, the last portion is concerned with the task of the psychologist who works among the blind and the severely visually-impaired. In Czechoslovakia, where this work was undertaken, this kind of professional activity is relatively new and represents pioneer efforts. For this reason the concept seemed inappropriate for discussion in this paper.

SUMMARY

Several problems relating to the inner life of the visually impaired were studied. An attempt was made to describe the emotional strain in the life of the severely visually impaired and to discover whether it was as stressful as the objective visual deficiency. The causes of emotional strain were sought among the stresses, frustrations, and conflicts of their life situations. Their sensitivity to the so-called higher or social needs was also analyzed and compared with frustration levels at the level of lower or biological needs. Further investigation was made into the character of modes of coping with stressful life situations. Special attention was paid to defense reactions showing clear indications of maladaptation. The causes of physical appearance

and the ways these were acquired were also investigated. Last, the role of the life history of the visually impaired was considered, including the influence of personality traits on modes of coping with stress situations and on the specificity of behavior.

Translated from the Czech by J. Krivohlavy

A NEW BRAILLE MEDIUM

Robert C. Ondricek
Frank P. Meehan
James C. Love

ABSTRACT

Tactual Horizons, Inc.,* a non-profit corporation, is developing a system that could significantly affect braille publications. Their availability would be strikingly increased, and their cost would be sharply reduced.

This new system will accept compact, coded inkprint information and convert it into a form acceptable by a tactile transducer (a machine that converts the inkprint medium into a form accessible to the blind person). A less than $500 cost-per-device, including transducer, is projected.

Enormous savings will be realized by this new system for the following reasons:

1. A standard sheet of inkprint paper (8 1/2" x 11") can contain more information than a standard volume of embossed braille.
2. The cost of each sheet (*volume*) would be less than a half-cent.
3. It can utilize normal inkprint production procedures.

Additional major advantages are:

1. Only a small number of new, additional personnel will be required, since a departure from regular braille production occurs only at one point when the stereotype plates are created.
2. The reduction in bulk will make it practical for a blind person to have his own library.
3. Machine reading will put little or no wear on the medium.
4. Current photocomposition techniques (which are 100 times faster than stereotyping) allow same-day mailings of topical material.
5. Mailings may be first class because of the enormous reductions in weight.

INTRODUCTION

This paper gives a brief history of the system's development, followed by detailed descriptions of the system's components and their stages of development. It also describes briefly some of the problems to be solved and plans for the future.

The system has three distinct components:

1. The inkprint medium. It is composed by computer, typeset by photocompositor, and printed by photo-offset.
2. A reader/optical-scanning device. It reads, decodes, and temporarily stores the inkprint information.
3. A tactile transducer. It presents braille to the blind user at his own speed of reading.

Tactual Horizons, Inc., has concerned itself primarily with developing the first two components.

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BACKGROUND

In January 1971, Frank Meehan conceived the idea of using printing production techniques that might drastically reduce the costs of printing braille, and subsequently enlisted the help of the coauthors to explore the problem further. Our background is in data processing and printing, including photocomposition. None of us had previously been involved with blind persons except in the remotest way.

Since we knew of the advances made in developing optical character-recognition machines (OCR's), we considered microfilm and other compact media. But the relatively high cost of microfilm made us consider ink-printed paper as the medium.

It is known that halftones of up to 200-line screen are routinely produced for glossy magazines. This means that 40,000 points of information per-square-inch are regularly produced in a printing shop. If only two values-per-spot are selected--white or black--it is then possible to encode 40,000 bits of information per-square-inch. This is equivalent to more than 6,600 braille characters--compared to the 12 per-square-inch of normal embossed braille--or more than 500 times the embossed amount.

Thus encouraged, we next had to consider the problem of creating such compact information as well as a method of reading it.

It was immediately apparent that neither linotype nor monotype, nor any other traditional (hot metal) composition technique would suffice. But the relatively new field of photocomposition (cold type) presented a different picture. Photocomposers can be driven by the output from computers and are capable of a great deal more accuracy than are human-oriented hot-metal linecasters. A certain subclass of these machines comprises the digital-digital photocomposers. Most of these devices can lay down information in increments of less than one-thousandth of an inch. It is interesting that the digital-digital devices are considered the least accurate of available photocomposers for resolution of individual characters, but they are typically very fast and many can produce more than 1000 characters-per-second (Hz), while some claim rates of 6000 cps. Thus, a figure of 500 cps is reasonable for estimating.

It appeared, then, that various options were possible in selecting a production photocomposer. The devices have a wide range in price, but that is of no concern at present. Since access to a Linotron 505 (a digital-analog device) was available, a sample composed of four-point periods was created. The sample utilized a simple encoding scheme (since abandoned) which contained about 1100 braille characters-per-square-inch.

Logos Designs, Inc., an engineering firm, was approached with the problem of building an inexpensive optical reading machine to handle this medium. Although they were skeptical at first, the engineers quickly developed an understanding of what was desired.*

It was decided that Logos would approach the problem by determining how small a dot could be read cheaply. To do this, Logos would forego the available sample and concentrate on testing, utilizing actual halftones. New samples provided to Logos Designs consisted of sheets of halftone dots. These sheets were printed from industry standard 100- to 200-line screen at values varying from 10 to 90 percent. (The term "line screen" refers to the number of dots-per-linear inch, and "value" refers to the portion of the unit square that is black: i.e., covered with ink.) As a result of these tests, 100-line screen at 20 percent value was chosen. A further test of trackability was then devised.

Rather than be held to a particular photocomposition machine, a mock-up input was decided on. Utilizing a monotype machine with em-sized solid boxes, quads, and techniques of photo-reduction samples closely approximating what a photo-

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*Tactual Horizons, Inc., came into formal existence at this time.

composer could accomplish were produced for testing. These sheets contained little if any intelligence.

Our first concern was to be able to track one line of data at a time. Therefore, the initial breadboard device was permitted to read only one line continuously. Its output was connected to an oscilloscope to monitor its activity. These tests were positive, indicating that the device would keep on the same line even over wide (0.08-inch) lengths of white space.

Nevertheless, an encoding method which maintained a maximum white space gap of 0.01 inch was established. This method guaranteed reliability and incidentally simplified later programming requirements. Simply by manipulating the lead (vertical spacing) in the monotype sample, we were able to provide more defined sheets to the engineers. These contained 10,000 dots, or 1600 characters per-square-inch of coded area. They also contained intelligence in the form of braille-encoded messages that could be interpreted by the computer in the testing setup.

When it was determined that this information was actually being picked up with regularity, the breadboard was attached to a minicomputer to check the accuracy of the material being read. A program for the minicomputer had to be written to treat the optical reader as another periperhal device, such as a paper tape or card reader. It was soon obvious that the reading process was extremely accurate and that a given line could be read for hours at a time without error.

It was also foreseen that the information could be read faster than almost any blind person could read braille--50 characters-per-second, which is equivalent to more than 600 words-per-minute.

At this point, a clearer idea of the final production cost of such a machine became available. Taking into account that an output transducer would be required, it was felt that costs would stay within practical boundaries. Therefore, the development of a full-sheet reader was started, and all indications of its practicability are promising.

Other major problems coincident with the system were not ignored during this development.

The necessity of a transducer and its various ramifications were discussed. During a review of the literature and discussions with people who assist the blind, we became aware of a great deal of work that had been done in the area of tactile transduction, including braille display belts. We therefore decided not to involve ourselves in the design of such devices, as we hoped to be able to utilize whichever of the existing devices proved to be the best. We were, and are, quite confident that the output of our reader could act as input to any of the devices to be mentioned below.

The problem of creating input to the composition program also requires consideration, but this is not of vital concern, since various programs for the translation of Grade 2 braille into normal English are already in use.

In his desire to see the project rapidly advanced, Frank Meehan underwrote the creation of Tactual Horizons. In his enthusiasm and because of his conviction that a working model should be available before approaching any charitable foundations, he has continued his support, perhaps overstepping his limited funds.

THE MEDIUM

No final decision about the output of the transducer has been reached. This output could be virtually anything, even compressed spoken letters, but for the purposes of this paper, an output of braille is assumed.

At this writing, the medium of choice is inkprinted, 8 1/2" x 11" 80-pound clay-coated opaque paper. Later it may be determined that a lighter, less expensive paper could be utilized. This paper, though relatively heavy, costs less than a half cent a sheet and would come to 200-250 sheets an inch. It can also be printed on both sides.

Data will be encoded serially. Instead of the three-row by two-column array of the normal embossed

braille character, we will have a one-row, six-position array. If we use the standard American notation for the subcell positions, our linear array will correspond to positions 1, 2, 3, 4, 5, and 6 (Figure 1). These subcells or dot positions will be encoded at 100 to the horizontal inch and 100 lines to the vertical inch. The use of at least six horizontal inches provides for 600 subcells or 100 characters-per-line. The use of 10 vertical inches (for lines of data) yields 1000 lines-per-sheet surface. Printing on both sides of a sheet gives us at least 200,000 usable braille character positions per sheet.

Before examining the medium in more detail, it might be well to review some characteristics of embossed braille and to compare the two media. For book production, embossed braille is presented on 11" x 11 1/2" sheets having 25 lines of up to 37 characters each, yielding as much as 925 characters-per-surface.[1] In volume production pages are embossed on both sides through the process of interpointing, and a volume can contain up to 100 pages. Thus, a braille volume could conceivably contain up to 185,000 characters. This figure is less than that which can be contained in a single encoded inkprint sheet. Note also that the embossed braille volume would be at least two inches thick and weigh two or three pounds.[2]

To relate these figures to normal inkprint books, we must consider what braille really is. There are many forms of braille. Though nominally a translation of inkprint characters to a six-bit transcription code permitting 63 nonblank variations, conventions have been established which allow much more than a letter-for-letter translation. There are Grades 1, 1-1/2, 2, and 3, music and mathematical codes, and various shorthands.[3] The purpose of these codes is to present English or other character sequences in as compact a form as possible while maintaining uniqueness of coding and readability. However, regardless of the grade or type of braille chosen, it will still be a six-bit code and acceptable to the proposed system.

Grade 2 braille is the most frequently used code for book production in the United States. It is a translation scheme in which there are 189 contractions of English letter sequences into shorter braille characters. Certain common words are abbreviated and certain letter strings are collapsed into one or two braille characters. The translation of English into Grade 2 and back again is no small task, since the same braille character can have up to three meanings depending on whether it falls at the beginning, middle, or end of the braille-encoded word.[1]

Notwithstanding these difficulties, much has been written concerning the automation of such translation via computers[4, 5, 6, 7, 8, 9] and at this point several programs are available that can perform this translation.[4, 10, 11, 12, 13, 14, 15] The translation is of course crucial to implementing the system

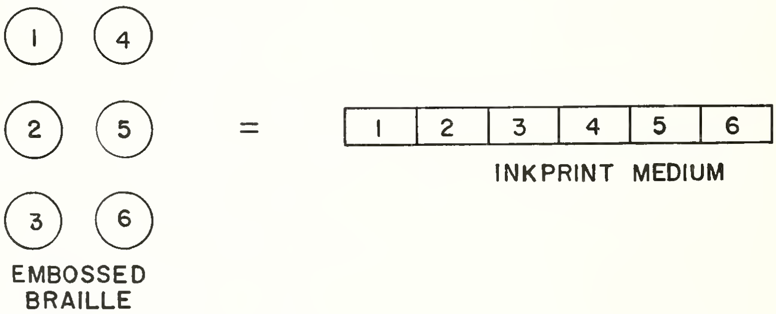

Figure 1. Data Arrangement Comparison

as we now see it. It has been stated that Grade 2 achieves a 40 percent compacting of characters over Grade 1.[4] This percentage cannot be related directly to normal English because some situations in inkprint require more than one braille character.[1] However, using a factor of one-third fewer characters in Grade 2 braille than in English is probably fair. A figure of 2100 characters a page in a paperback edition (42 lines of 50 characters each) is reasonable for comparison purposes. This yields about 1400 braille characters for the same page or one and one half braille pages per inkprint page. (Goldish[2] and others use a figure of two to one, but we need not quibble.) If we compare either figure to the inkprint medium, it is implied that more than 110 normal inkprint pages can be contained on one sheet of the inkprint encoded medium. Thus an entire paperback book could easily be put on to two or three sheets, a textbook on five. Another example, the *Readers' Digest*, which is also produced in braille, consists of four volumes of less than 50 leaves each. Each surface contains 33 lines of up to 40 characters each. This gives a maximum content of 528,000 characters per magazine, and can be contained on three inkprint, dot-encoded sheets.

All these figures ignore the fact that nowhere near the maximum number of characters is utilized in embossed braille. The lack of interpointing on title pages, the occurrence of the page number and title on each leaf, the notable absence of hyphenation in the computerized translations, and the character positions lost at the end of paragraphs all contribute to waste. Little if any of this waste need occur in the inkprint encoded medium, but it would be an unnecessary conceit to adjust the figures to account for it. Also, it should be noted that there will be certain areas of waste, which are subsequently discussed, taking up some of the slack.

Finally, we will develop a comparison of the volumetric requirements of the media by finding approximate character-per-cubic-inch capacities. For embossed braille, using the generous figure of 50 sheets or 100 surfaces-per-inch, we obtain 1200 characters per-cubic-inch. For the inkprint medium, using 200 sheets or 400 surfaces-per-inch, we have a total of 666,000 characters per-cubic-inch. This implies an ability to get more than 500 times as much information into the same volume. Note that our medium compares favorably with magnetic tape. A rough calculation reveals that 100 sheets of our medium could hold as much as a full-sized computer magnetic tape (2400 feet at 800 characters-per-inch at 80 percent usage).

ANCILLARY REQUIREMENTS

A more minute description of a dot is in order. Each dot or subcell position can be thought of as being contained in a square with an edge of one-hundredth of an inch. To allow separation of lines the top half is always white. To facilitate tracking, each subcell has some black in it. More precisely, exactly half of the bottom half is always black. Thus, to represent the presence of a braille dot the bottom left quarter is black and the bottom right quarter is white. Conversely, to represent the absence of a braille dot, the bottom left quarter is white and the bottom right quarter is black (Figure 2). Therefore, in the coded area, exactly 25 percent of the area is *always* black. This aspect of apparent redundancy in coding permits rather primitive logic in the scanning mechanism, which allows a lower cost-per-unit and greatly enhances the reliability of the reading mechanism.

Certain elements are used to bound each line. These elements are a solid black lead-in line, a synchronization character, and an error-checking character. The solid black lead-in line, which is one-half inch long, serves two purposes: it allows easy passage from one line to the next by acting as a stopping point when the paper is advanced, and it allows the differential tracker (to be discussed later) to establish a correction for any skew that might exist in the line or paper before any data is encountered. The synchronization character acts as a signal that the data is soon to follow, and because of its known configuration could allow timing

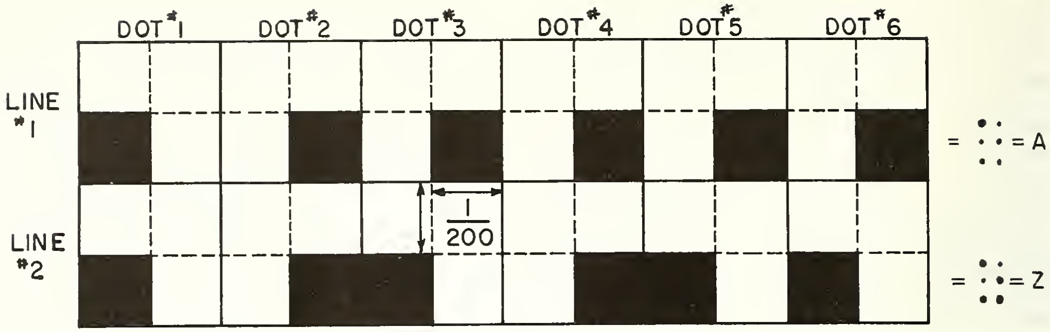

Figure 2. Some Inkprint Encoded Letters, Enlarged 100 Times

modifications to take place. No such modification takes place in the current prototype, though it might in future models. It currently provides a white spot to signal the end of the lead in. The error-checking character will be a simple binary hash total and will allow for any necessary error detection. This character has not been included in the current test material, nor has its necessity been established. It is likely, however, that such a checking mechanism would be standard. (Figure 3 illustrates these elements.)

It might seem strange that in order to simplify the various mechanisms, the device will be required to read backward as well as forward. This, however, allows for an easier line advance. To facilitate this design criterion the right-hand side of each line will contain almost the mirror image of that contained in the left-hand boundary. Thus, we have the line ending with an error-checking character, a synchronization character, and a solid black lead-out (in) line. The reading will not be truly boustrophedonic.* Each line can be read by the device in either direction. One of the functions of the "reader" will be to keep track of which direction it read a given line and how many characters it read in the line. This will allow the "reader" to empty its buffers to the transducer in a presentable fashion. It also allows an extra long lead-out line to be used at the end of a chapter or at some one or other meaningful break. Figure 4 illustrates the right-hand boundaries and Figure 5 an unenlarged sample.

With so much information on a page, it would be impossible to expect a blind reader to find his way or what he wanted without some assistance. This assistance may take the form of superdots. Superdots are reference-control bars, short, solid marginal lines (Figure 6) occurring to the left of the bounded information, which can be sensed and referenced independently of the data. These bars would be similar to the lead-in (out) lines in thickness and vertical position, and have a length of from 1/8 to 1/4 inch. Their use would facilitate a hierarchical accessing of various parts of the sheet. A level-one superdot could reference points corresponding

*Performed in the manner that an ox plows a field.

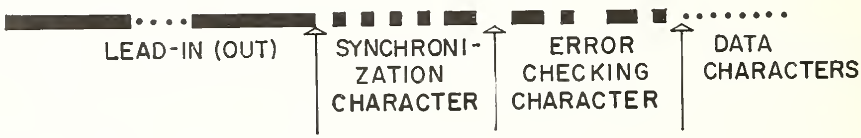

Figure 3. Typical Left Margin Boundary

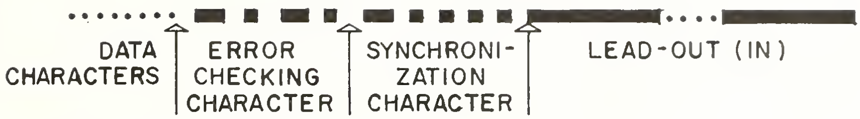

Figure 4. Right Margin Boundary, Corresponding to Figure 3

to a group of paragraphs or a page in the original ink print publication. A level-two superdot could reference a chapter or new article. A fuller discussion of these elements and their usage will be found further on in this paper.

Each page must be identified to the sighted and to the blind. To assist sighted production workers and those who might be aiding the blind reader, a normal full-sized (12-point) line or two of type will appear on both surfaces of each sheet. These lines will contain the publication's title, author, publication date, and sheet number.

To assist the blind reader in identifying each sheet we are considering two methods. The first is solid-dot braille.[16] A line of solid-dot braille--identifying title, author, and sheet number--could be set at the top of each sheet. These dots would not interfere with the reading device's operation. Solid dot was considered over embossing because of the characteristics of clay-coated paper.

The second method involves hole punching or drilling of braille characters on the side or bottom of the sheet. These characters could then be read by means of a stationary attachment to the device, which could be a small strip of tufted fabric dots similar to that described by Mann.[17]

The aspects to be considered in the creation of these sheets are how things are done now, and also what the future promises; necessary departures and their feasibility; and a coincident comparison of techniques.

While many if not most publications are still directly stereotyped, the direction at the American Printing House for the Blind has been toward computerization. Utilizing their IBM 7040, they have succeeded in automating their stereotyping. In this process, they keypunch the text in annotated English, which is translated into near-perfect Grade 2 braille, and then converted into punched cards which direct the stereotyping machines.[14, 18] In this respect it is interesting to quote from a 1956 study of this process: "It is reasonable to assume the books that have been completed through the use of this system are the most accurate in translation that have ever been produced."[14] Even making allowances for the care taken during a pilot project, the prospects are heartening, especially when one considers that this statement was made 15 years ago. For example, many such translation programs have been developed: Nemeth on the IBM 650,[4] Schack and Mertz on the IBM 704,[4, 12] and the MIT group with DOTSYS III on the IBM 360/67.[19]

There has also been much speculation and work toward utilizing publishers' production tapes.[10, 11, 12] These tapes, used to drive both hot metal and photocomposition devices, have had varying degrees of accuracy associated with them. There is every reason to expect that as means of correcting them are found, and as programs are written to utilize them, these tapes will account for the major source of input to the braille production cycle. One investigator has even suggested that publishers be asked to submit these tapes to the Library of Congress, together with the inkprint publications.

While there remain mixed feelings about the use of optical character recognition (OCR) machines as a means of obtaining input directly from printed publications, their

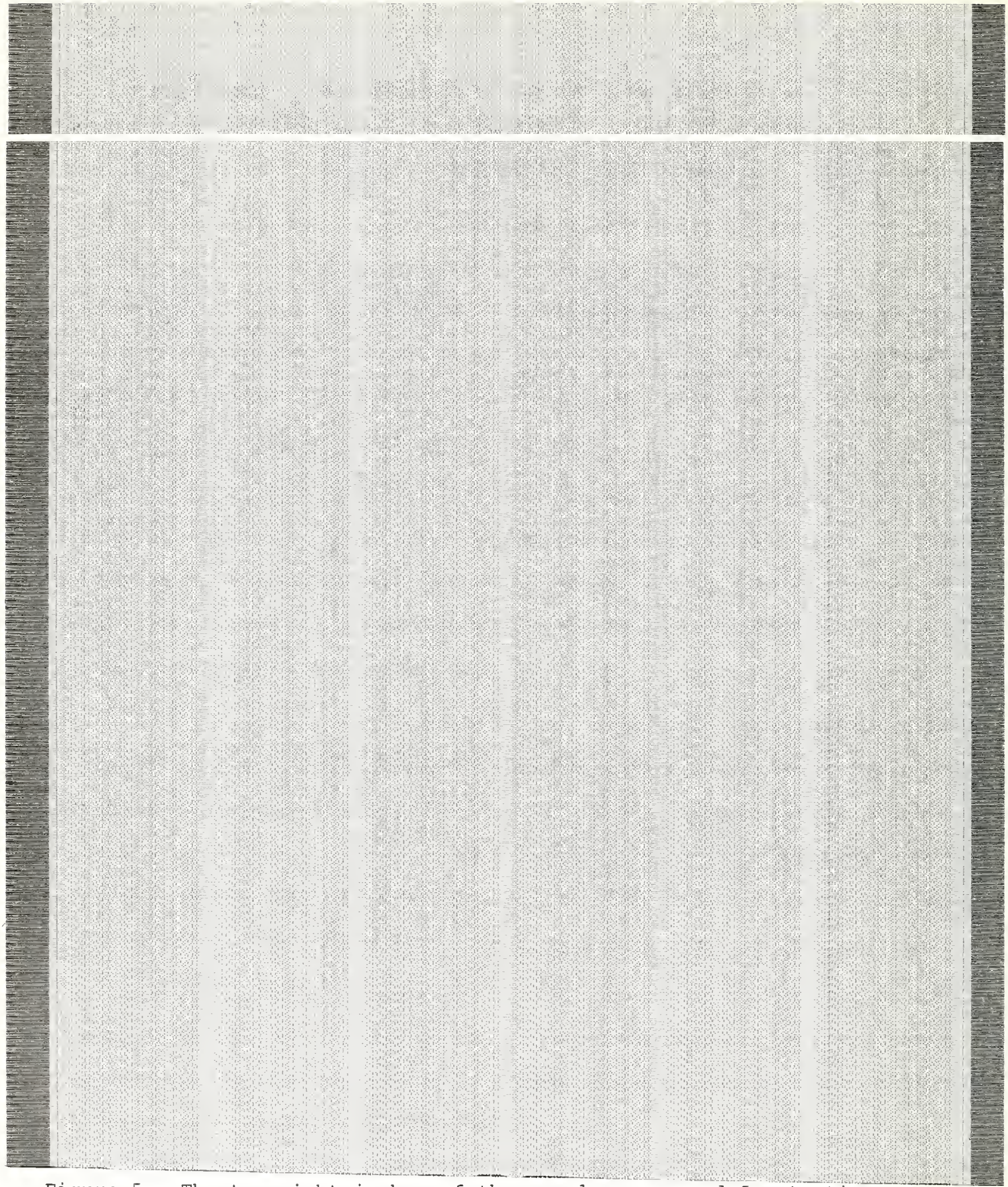

Figure 5. The top eight inches of the sample page used for testing. (The portion shown contains 80,000 braille character equivalents, but no "superdots" or "hash totals." The gap and its coincident misalignment were accidental, but proved useful in checking line to line movement. Incidentally, the first inch of the first line reads, "(Can) (you) r(ea)d (this) l(in)e?"

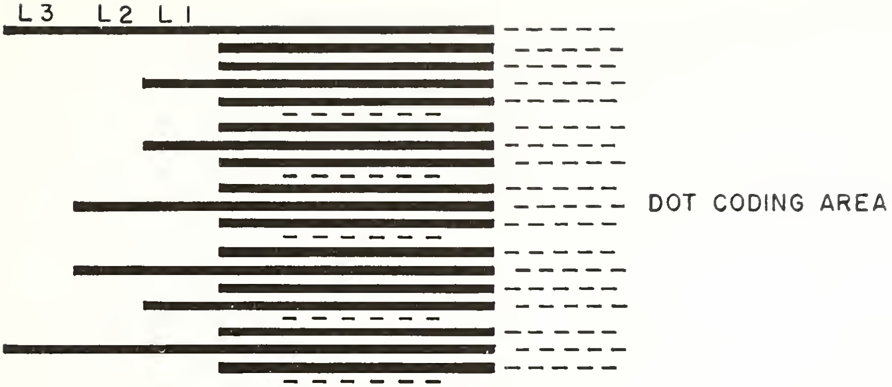

Figure 6. Superdot Structure. Dashes in Lead-in Area Indicate Presence of Many Non-superdotted lines.

future use should not be discounted. Devices with any flexibility cost around a half a million dollars. However, two of the authors were involved in a trial project in which such a device "read" a novel which had been printed in England. The results were spotty, but they did indicate the great potential of the device. Still, the use of typewriter-font OCR devices show marked advantages over the use of key punchers in the creation of initial input. The ease of proofreading typescript (and in many cases the ease of correction by use of interlinear modification), as compared to punch cards should be noted, and their price of $10,000 to $50,000 is continually dropping.

It might be well to update Goldish's[2] figures concerning publishers' use of computers in 1966. According to an industry newsletter,[21] there are over 1000 computers in use in the United States (and almost 500 more internationally) for purposes of composition. This almost fourfold jump in five years must convince even the most skeptical of the increasing reliance on the new technologies. This same source reports well over 800 photocomposition devices in use, which, incidentally, is a gross underestimate. This explicitly does *not* include tape-driven hot-metal machines.

In any case, it can certainly be expected that as photocomposition is increasingly used in normal book production a greater amount of data will be immediately accessible to computerized processes. There is also no question that periodicals, especially dailies, are tending toward automation. Thus, it is reasonable to expect that *The New York Times*, *The Wall Street Journal*, *Newsweek*, and others will be available in this form. At present there are no weekly newsmagazines available in braille. This is no doubt partly because of the rather slow rate of a card-driven stereotype machine. Such devices do not produce more than 12 plates or 24 pages an hour.[18] This, together with the problems of input preparation, and the sheer bulk of it all, contributes to the slow dissemination of embossed braille material.

Where does the proposed system fit into this process? Our innovation would begin at the point where the translation into Grade 2 braille was complete. At this point we would substitute a photocomposition program for the stereotyping program. This rather simple program would carry out much the same process as the stereotyping program. However, the output would be magnetic tape to drive a photocomposer rather than the traditional cards of the current program. On that basis alone it would be much faster. It should be noted that a program of this type is state of the art. Such a program is being written by the authors to run on the IBM 360/30 to create input for an RCA VideoComp 70/830 photocomposer. A computer composition rate of 5000 characters-per-second would be quite low and a rate of 15,000 cps very possible. Compared

to the rate of translation of 1000 words-per-minute,[4] the insignificance of the extra processing becomes obvious.

A short description of the photocomposition process will clarify our requirements.

Photocomposition is analogous to the hot-metal line-casting process in that each character is generated from a master image. In hot metal technique, a master (matrix) exists for each letter or character in each of the required point sizes, and from this master individual characters are recast each time they are called for. In cold type, the same master may, by optical or electronic enlargement, serve for many different sizes. What is germane here is that individual characters are "painted" on photographic paper or film. In the early machines (analog-analog), they were painted with one sweep, i.e., a light flash through a transparency of the character. Later machines used many strokes to paint a character. The most common method draws very thin vertical lines, one after another, while the height of each stroke is determined by a transparency (digital-analog) or is stored in a digital form which is accessible to the device (digital-digital). The typical machine of the latter type can paint strokes less than one-thousandth of an inch apart. It is apparent that our solid 1/200-inch square boxes would require a number of such strokes.

Though the box is a trivial form, problems can arise because of the characteristics of a particular device. For instance, one must have the capability of getting close to 100 lines-per-inch, so we are not entirely free in the choice of the photocomposition machine.

The following five machines meet the necessary requirements: the Harris Intertype Fototronic CRT, the Hell Digiset 40T1, the Photon 7000, the RCA VideoComp 70/830, and the SEACO 1600. Each of these is a digital-digital CRT (cathode ray tube) device. They range in price from $125,000 to $380,000 and all can be driven by magnetic tape, while some can accept paper tape as input. They have claimed speeds in the range of 300 to 6000 cps.

From among them we can choose as our standard the relatively cheap Photon 7000 ($125,000 with paper tape input, $145,000 with magnetic tape input), which has a theoretic maximum of 6000 cps. (This figure is nominally based on four-point adjacent periods in the lowest resolution.) For our purposes, we may safely project a rate of 500 cps. This figure provides four strokes per dot and allows for the lead-ins and other extras required to set a line. This rate implies the ability to turn out a braille volume (both sides of one sheet) in seven minutes.

We might also consider the much slower (30 cps), less expensive ($65,000) Harris Fototronic 1200, which is driven by paper tape. This analog-analog device, running in 7 point with 20-unit characters, would require 6.08 inches per 100 characters. Using a figure of 120 characters to generate a line, we find that one side of a sheet will take 4000 seconds. Thus, it could take 2-1/4 hours to generate a volume.

Comparing the 8-1/3 hours required to prepare the same amount on a stereotyper, we find that the Photon will do it 70 times as fast and the Fototronic 1200 amost 4 times as fast.

In passing, two points should be made: none of these machines would give precisely 100 lines to the inch, but the variation, for 1000 lines, of from 9.72 to 10.04 inches is acceptable. Also, it is usual to find machines that are rentable at rates under $25 an hour.

After the photocomposition process the sheets can be prepared for photo-offset printing. This process allows us to print both sides of up to 16 sheets simultaneously. This printing, and the later cutting, allow registration of the sheets to be routinely accurate within 1/500 of an inch. This accuracy is easily maintained at rates which permit well over 5000 sets of sheets to be produced in an hour.

The requisite solid-dot add-on, or hole creation, is thought to be a bottleneck of a minor and surmountable nature.

Coincident with these operations a true embossed braille title page would be created to act as a folder for the encoded inkprint sheets. This folder would also contain a table of contents, referencing the superdots on individual sheets.

We therefore have a situation in which all current personnel can be economically utilized in tasks congruent with those which they now perform, and they could also be a great deal more productive.

It should be noted that while the clay-coated stock should hold up well in use, we could use mylar. Certainly the fantastic reduction in volume would allow for greater expenditures on the medium for an edition that will have a lot of use.

THE OPTICAL READING DEVICE

Three variations of the machine which reads the medium are discussed here:

1. The current test device in which only the medium moves (Figure 7)

2. The soon-to-be-completed full-page reader in which the optical system also moves (Figures 10, 11, and 12) and

3. A production model.

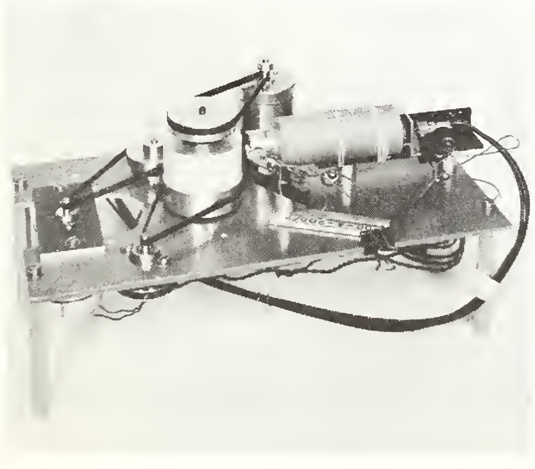

Figure 7. The Original Breadboard Reader, 12 inches long.

Figure 8. Front Top View of Page Reader, with Spring Door Open, 12 1/2 inches in length.

In this discussion we take pains to avoid confusion among the three. The nature of our investigation makes it difficult, however, to segregate the descriptions. Note that when the phrase "in volume" is used we imply quantities of 1000.

Before going into the technicalities of the devices it would be well to list the production device's chief requirements. It will be an optical recognition device that, after automatic registration of a sheet of paper, will read one line at a time of encoded dots. It will collect groups of six dots into characters, hold a number of them, and later feed them to a braille transducer. It will be inexpensive, transportable, indestructible, and easy for a blind person to maintain. During the reading process it will change lines automatically and be able to read in either direction. It will also incorporate certain control functions. These functions, activated by buttons on a control escutcheon, would include the ability to stop, to skip forward or backward on a line or to a given superdot level; to lock at a given superdot level; and to eject the paper. An additional very important function would provide the number of the media line currently being read to the transducer. It is assumed that the optical reader will react in normal use to signals from the transducer regarding requests for characters and, therefore, lines or buffers.

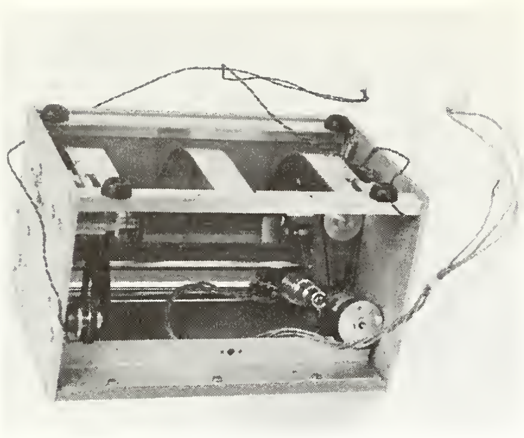

Figure 9. View of Page Reader from Back Bottom, Back Plate Removed, Showing Drive Motors, Paper Guides, and Optics Cylinder.

It is also fairly obvious that the device must be able to read quite a bit faster than a very fast braille reader.

The following paragraphs, without attempting to be exhaustive, outline the various components required by the devices. We have tried to present logically the most important components in a functional sequence. A detailed parts list is supplied in the appendix, and estimates of total costs will be presented later.

These units "see" inkprint squares having an edge of 1/200 of an inch. They track lines composed of these squares via optical magnification and the use of phototransistors. Two small light sources (Pen-Lite No. 222 bulbs, costing less than 5 cents each in volume) illuminate the paper; the spot image, magnified 10 to 12 times, is projected by a 7mm f/2.7 wide-angle lens on to three phototransistors positioned at the image plane. The bulbs are hand-selected for appropriate projected spot characteristics (which might exclude half of any given batch). They can be expected to last 5000 hours, while a lifetime of 50,000 hours is possible. Even if one should burn out it is expected that the remaining bulb would supply sufficient illumination. The lens used was designed for an 8mm movie projector and cost approximately $4.

The phototransistors, which for the sake of brevity will be called sensors, are lens-end metal cylinders about 0.06-inch diameter and 1/8-inch length. They are Clairex (CTL 4170) models and cost $4 each. In volume the triads could be bundled at $3 a set. One of these sensors is used for reading the data and the other two are used for tracking the line. The sensors are arranged in a compact triangle, the vertex sensor being used to read the data, and the base sensors, straddling the data, to allow tracking (Figure 11). The magnification of the system is set so that a black square will entirely cover a sensor. This means that the data (vertex) sensor will be entirely covered when positioned over a dot. The tracking sensors (base), positioned one above and one below the line, will each be 50 percent covered when in the middle of a black area. This allows a comparison of outputs from the two sensors to be made and appropriate differential corrections to be transmitted to the vertical-positioning servo. The phase-encoding system greatly facilitates this method of tracking. Since the maximum white area to be traversed is 1/100-inch long, the "track" can be held without fear of losing the line. Any necessary "course correction" will be supplied when the next black square is encountered. These sensors are used

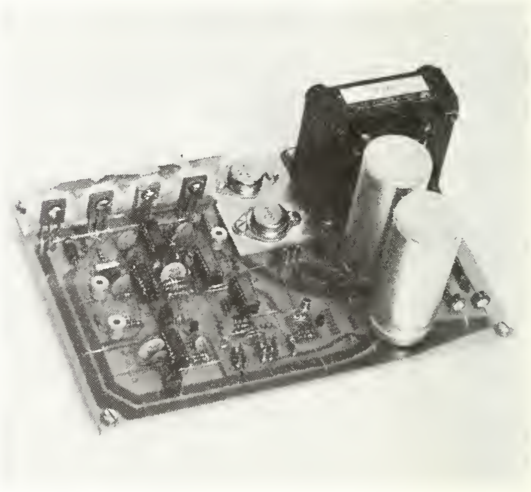

Figure 10. Electronics Board of Page Reader, Which Is Also Part of Back Plate.

as a variable resistance, which has a constant potential-drive input and a variable current as output. This output is then converted to a potential in the integrated circuit operational amplifiers. Additional operational amplifiers act as a data detection unit by comparing their input against a fixed white-black threshold. When this threshold is exceeded, the occurrence of a white area is indicated. We investigated the use of a differential system for data detection in which the track line of the subcell would be measured against the interline clear space. In the page reader an additional sensor will be used to measure the light level of the background. The output of this sensor will provide a data-detection circuit with a variable threshold. Therefore, smudges on the paper or variability of illumination will have little effect on the integrity of the reading.

The optical system has a total length of less than four inches and will be housed in a cylinder 7/8-inch diameter.

The design of the devices involves two servo systems. One servo is a velocity system which drives the sensor bundle along a data line at a constant rate. The other, a vertical-positioning servo, reacts to the differential tracking sensors and line advance commands. These servos are embodied in two small dc motors. They are a good grade of 12-volt, dc, servo motor made by Pittman and retailing for about $13 each. In volume one could expect to pay $3 each for them.

In the current breadboard the test sample is wrapped around a 2-inch-diameter cylinder and the horizontal servo rotates this cylinder so that the optics may remain stationary. In this setup the vertical servo drives the *cylinder* up and down. In the page reader the vertical servo will move the *paper sheet* up and down, and the horizontal servo will drive the optic's cylinder on a track, back and forth, across the page.

The motors now being used are ten times as powerful and twice as large as necessary. But their availability, reliability, and unlimited endurance outweigh this apparent extravagance. The necessary

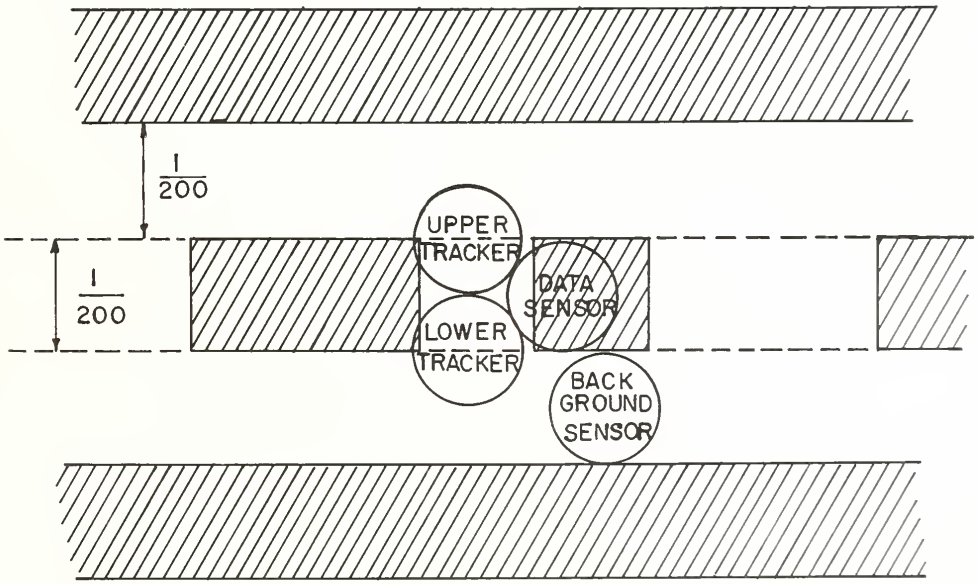

Figure 11. Position of Phototransistors with Respect to a Line.

speed reduction was accomplished by the use of belts and pulleys. The belts are made of 1/4-inch rubberized woven polyester, are very stable, and have a long life expectancy.

The horizontal-velocity servo utilizes the back EMF on the motor, which provides a tachometer-like feedback, to maintain a constant velocity. In the future the self-clocking nature of the phase-encoded dots could be used to provide the feedback for the servo. The current "breadboard" tracks the data at 1/2 inch-per-second. This rate is the initial setting, and in no way reflects the capability of the system. In fact, it it mechanically more difficult to "belt down" to this rate than to read at a faster pace. The page reader will be driven at three inches-per-second, which is equivalent to 50 cps or over 600 braille words a minute. Scharff, in his comments on character recognition, states that the paper drive and logic are the limiting factors on speed.[22] Our engineers assure us that rates upward of 1000 cps are obtainable.

In the breadboard model now being used, turning on the device starts the horizontal drive motor, which rotates a cylinder. The direction of motion is neither stopped nor reversed by any condition. Not that it cannot stop, but such activity is simply not requested. In the page reader, physical barriers or "stops" will cause it to halt. Reversal of direction and/or the signal to start reading will occur when an empty buffer is sensed. Thus, it is possible that the optical reader will be idle for much of the time. The time it takes the mechanism to "get up to speed" is about 5 milliseconds.

In the current system the vertical driver acts at a rate of 1/2 inch-per-second also. This means that lines can be advanced in 18 milliseconds, which is the time it takes to read one dot. It also implies an ability to track lines that are skewed up to 45 degrees. Stepped up horizontal velocity applies here also. Thus, it is seen that the mechanical aspects of the optical reader do not offer any great difficulties. In short, the breadboard, which does not stop rotating is·capable of sensing the lead-in, initiating a search for the next line, and correcting its tracking motion in time to read correctly the new line.

There are many other elements involved in the device, of course, including the power supply, control logic, and reader package. The current total cost of electronic components is about $100. This cost would be reduced in series production of the system. It is not really appropriate to include the cost of hand-made pieces of our model at this time. We will bypass a detailed review of these elements so that we may consider the most important remaining factor.

Test work, now under way, utilizes a minicomputer (a Control Data Corp. PDP-8) for the breadboard's data processing. Using the computer allows us to control the servos, to collect the data, to convert the data into readable form, and to keep error statistics. The PDP-8 can also respond, via program modification, to unexpected conditions that may be encountered such as a variation in the error character checking procedure. These services are important in the testing situation, but analogous functions will also be required in a production model. Thus, we can state firmly that *the finished product will contain a computer*.

This does not mean a computer as currently understood but a *micro*-computer, incorporating a few integrated circuits or "chips." A computer circuit can be fabricated using metal oxide semiconductor (MOS) circuits which allow a complete central processing unit to be organized in a single 1" x 1/4" x 1/2" chip. These devices are currently being used in small electronic calculating machines. Intel Corporation, a typical manufacturer, currently provides two series of chips, the MCS-4 (4 bit) and the MCS-8 (8 bit), from which a user may select the units necessary for his application. We have chosen the MCS-8, as the 8-bit data path is more appropriate. The control-processor contains no memory; additional chips, containing "read only" and random access memory, will be added as the programming requirements of the final system are determined. When this determination is complete the program can be converted to

permanent read-only-memory (ROM). Once set, such a memory will be unalterable, as its program is fixed in a metal photographic mask, and can be reproduced in any quantity desired. The initial reader computer units may use an alterable ROM, which may be programmed through the use of special equipment as many times as necessary. This type of memory is almost as permanent as the metal mask, but it is more expensive because of its special packaging. It is believed that it will hold its program up to 100 years. According to Intel's price schedule, a lot of 100 such computing clusters might cost $160 each at present. Our engineers' experience in this area leads them to believe that the price will drop to $50 each by 1973.

What, precisely, would this computer control? The computer asks the horizontal servo to drive right (meaning direction). It then marks time while passing through the lead in, and when the first white spot of the synchronization character is encountered, it is set to bypass the character (and possibly the hash total) and accept what follows as data. The computer knows how much time it takes to pass over each element of black or white (0.01 seconds at 1/2 ips, or 0.00166+ seconds at 3 ips). It uses the first half of each cell to determine the type, and for the center to re-establish position. As a result of these tests, it determines the presence or absence of a braille dot, or the presence of the solid black lead out which would complete a line. As the line is passed, successive bits in a buffer are set on or off accordingly. The bits are treated in groups of six to permit maintenance of a character count and a running hash total (a binary sum, without carry).

The end-of-line condition is signalled by the occurrence of the lead-out line, a full buffer, or a physical stop. In the first two instances, the carriage will keep going until it meets its stop position, but no additional data will be read. At this end of line, the computer gets rid of the terminal synchronization character and its effects. It then uses the hash total to determine if an error in reading has occurred. If an error has occurred, the computer causes the line to be re-read in the other direction in an attempt to obtain a correct reading, failing which the user would be signalled via the transducer that an unrecoverable error has occurred. If there was no error, the computer gets rid of the hash total(s) and saves the count of characters read as well as the direction in which the line was read. It then initiates a vertical drive to the next line, whereupon it stops and waits. (In our test system, we print out the line just read and ask for the next line.)

The transducer, meanwhile, would be asking for one character at a time from the appropriate buffer. The use of a pointer to the next available character, and the direction read, provide the program with sufficient information to give the character to the transducer or to find that the buffer is empty. If it is empty, two activities occur: the next buffer is used to supply the required character, and horizontal movement is initiated to fill another buffer. The speed of such computers is so great that a character can be supplied to the transducer in much less time than it takes to read a character, therefore, no conflict need arise.

It is expected that the memory capacity will permit three buffers to be used. This allows the line previously read to be saved, and permits backing up one line without involving the optical reader.

When reading right to left the computer will fill the buffer, character by character, top to bottom. In a reverse read, the buffer will be filled bottom to top (backward). It will be left to the sub program (which supplies the transducer) to organize the characters.

The computer would also handle signals from the control escutcheon on the transducer. Most of these signals would require line skipping, and thus would affect vertical movement only. The request for line number is different. It would translate the current line number into braille dashes, and then present it to the transducer and user. This function would be invaluable to the user in maintaining his place during interrupted reading.

The computer need not control the speed of the scanner or have any involvement in tracking, nor would it discriminate between black and white. These functions are maintained by an independent analog subsystem.

PAGE READER, DESCRIPTION

The reader will be contained in a metal box 12-1/2 inches long, 7-1/2 inches wide, and 8 inches deep, weighing approximately 15 pounds. The device will operate on normal ac lines and draw less than 8 watts of power. This is less than the drain of parking lights on an automobile battery, implying that it can be battery powered.

The unit has been designed to be durable and stable. Jarring will not vary the focus; it might not even cause a line to be lost. Further, even a fall of three feet is unlikely to cause damage. Constant vibration could disturb the reading process, but the user can usually control such conditions.

The worst problem anticipated is dirt which will collect from both paper and use. Therefore, the parts which can be affected have been situated in areas of least dirt accumulation. The device is also easy to disassemble for occasional cleaning of the dirtiest places.

In operation the device would be used somewhat like a pop-up toaster. A spring flap on the top front of the box is opened and a sheet inserted lengthwise into the slot which presents itself. As the paper is inserted, fixed, channeled-edge guides register the sheet horizontally. Except for a short strip at the top, the entire sheet fits within the box, and the far bottom edge of the box acts as a stopper for the feed process. This design allows a variation in paper width of 1/8 inch.

When the top edge of the paper falls below the top of the box, or when no more will fit, the spring door is closed. This activates the vertical registration process, which seeks the lead-in of the first line. This procedure allows the paper to be skewed 1-1/2 degrees. This figure is well within the range of the tracking mechanism. If we were to use a lead-in that reached the edge of the sheet, and thus allowed a skew of 10 degrees, the tracking mechanism would still not be troubled. The loss of sheets "down the hole," and creasing of sheets by the device, will be avoided by the use of standard-sized sheets.

The cost of building ten of these devices as production prototypes is estimated at $20,000, which includes from $500 to $700 each for cabinets and optical scanning hardware, and $700 each for the microcomputers. A single cell transducer[23] might be included, but the above figures do not include a sophisticated transducer or a control box.

It is also estimated that by 1973 a quantity lot of 1000 finished devices could be produced for less than $300 each, excluding transducer.

A few points remain to be considered. First, the device's acceptance of the possible line of solid-dot braille is assured. The line would occur atop the data and never actually enter the machine.

Second, the recognition of superdots (Figure 6) can be handled either by stationary sensors, or by using computer-resettable margin stops. The second method is currently favored. It would probably require extra programming of the microcomputer and the printing of superdots in both margins. In that case a "stop reading at superdot level x" command would cause the computer to reset its margins. Thus when the lead-out was entered, the computer, knowing how long it was, would bypass the lead-out and continue scanning until either "level x" was reached or white space was encountered. If white were found the device would quickly reverse its direction before it lost track of the line.

A "search for the next superdot level x" command would be somewhat more involved. Here, as each line was advanced, the scan would proceed to the sync character, stop, and reverse direction to gauge when the lead-in was bypassed, as in the above example. If the desired level were not found the head would be advanced.

These techniques might seem far-fetched, but they are easily programmed, avoid skew problems that might otherwise be encountered, and allow shorter lead-ins and superdot bars to be used.

It should be noted that we are still in the discussion stage with regard to the implementation of superdots.

THE TRANSDUCER

A transducer is a mechanism which changes the form of energy or power. In our case it refers to the conversion of electric impulses generated by the optical reader into a form acceptable to a blind reader. This form could be acoustic, tactile, kinesthetic, or even direct electric stimulation of the brain.

During our initial involvement, Tactual Horizons has considered the most obvious: the use of a single braille cell, electromagnetically controlled, to produce discrete tactual impressions to the reader's finger. But when we approached members of the blind community with this proposed output of our system, we were rapidly disabused of our confidence in the most "obvious" choice; the reaction was overwhelmingly negative. At that point we decided the best approach would be a review of the available literature. This, plus meetings with interested parties, convinced us that the negative reaction we encountered was well-founded. We also decided that since a great amount of work was being done in the area of transducers, our time would be better spent on other problems.

However, we could not avoid the necessity of demonstrating the feasibility of the system we propose. This has required an evaluation of extant and planned transducers, which in turn led to an evaluation of the methodologies employed. We have not collaborated with any of the people who developed the devices discussed below. It would be foolish on our part to criticize individual efforts. While we obviously have preferences, we shall try to restrict our comments to objective generalizations.

While completeness has been sought in this survey, no attempt at exhaustiveness has been made.

Most of the devices under discussion rely on some form of paper tape or magnetic tape input. There is nothing intrinsic in any of these devices that would prevent the use of an inkprint medium as input.

Because of long and successful use by the blind braille must receive primary consideration. Braille transducers may be reduced to three categories: single-character, line-at-a-time, and moving displays. The first of these must be discounted because of psychological and physiological difficulties encountered in their use. For demonstration purposes, however, we may find ourselves incorporating such a device[23] in the prototype page reader.

Line-at-a-time transducers are the most easily appreciated because of their similarity to conventional braille. They consist of a sequence of adjacent cells, each of which has bumps activated to simulate a line of embossed braille. Mann,[17] Fieldgate,[24] and the U.S. Office of Education[25] are some of the investigators involved with such systems. In each of these devices the actions of the user causes the next group of characters to be presented. One of the descriptions[25] specifically mentions the capacity to back up lines.

Various moving or continuous-display devices have been developed. Primary contributors include Bryce and Wheeler,[26] Grunwald,[27] King, et al.,[28] and Mann.[17] Each of these devices relies upon a single actuating mechanism to set braille cells. The cells pass beneath the reader's finger and at some later time are reset for read-out as different characters. The use of only one actuator provides an immediate economic advantage which is, however, offset by the requirement for variable-speed motors. All but the King device maintain a string of characters continuously available to the blind reader. Thus, if the movement is stopped, the reader can back up a few characters and retrace a poorly understood word or phrase. This

accessibility of adjacent information is a distinct advantage.

The work of Grunwald,[29] reported in a preliminary study of moving tactile displays, has produced an indication of another advantage of braille-belt display devices. Basing his tentative conclusions on the constancy of presentation rate, he finds that reading speed is helped by a moving (versus a stationary) presentation. We as sighted individuals can hardly ignore other apparent benefits of such devices. These would include not having to keep track of where the next line is with the other hand, and the ability to include a reference base for the braille character(s) which does away with the confusion of lower-cell characters with upper-cell characters (punctuation characters vs. the letters "a" - "j").

The need for a wide range of presentation speeds and overall sturdiness in the device must not be overlooked, but in light of our experience with the optical reader we do not feel these to be insurmountable problems.

Because of the above considerations, we are disposed to prefer the belt devices, and our future investigations will probably proceed along those lines.

Before moving on, we must mention the work of Saslow,[30] and Bliss and Crane[31] in the area of stimulation via air jets. The use of oscillating air jets in a simulated continuous display can be quite similar in effect to that of a moving belt. There might even be favorable compactness of design possible.

The tactile form, while the most obvious, is not the only possibility. We now turn to some nonbraille possibilities that could also use the inkprint medium for input.

The work of Beddoes[32, 33] on character recognition and the subsequent production of compressed spelled speech is interesting. The disadvantages in the use of spelled speech are apparent: a maximum of 110 words a minute, compacting without contraction, and the awkwardness of punctuation. However, the passive role taken by the user when utilizing our input medium would allow usage by the tactually handicapped, or the bedridden blind. The educational potential of a method of simultaneously presenting tactile and audible characters is also intriguing.

The work of Bliss on tactual and kinesthetic alternatives to braille provides much to stimulate thought. The use of typewriter simulation,[34] with a nine-dot code to indicate finger and direction of movement, has possibilities. (Here the first three bits would indicate which of eight fingers was being referenced, and the following three pairs of bits would indicate movement, if any, in each of the three possible directions (left-right, forward-backward, and up-down). Certainly, eight bits would also suffice, since "up" is unnecessary.

Cheadle[35] describes the use of a stenographic machine to convey information to the blind. As he describes his system, a 20-bit code would be required.

We may go a step further and suggest the use of tactile stimulation of the 24 interjoint segments[36] in conjunction with a stenographic code. Here, each interjoint segment would correspond to one of the 24 keys on a stenotype machine and would be activated by a bit in a 24-bit code. In stenotyping, a single 24-bit code represents a word, or at least a syllable, and offers the possibility of tremendously increased information transfer rates.

It is appropriate, in this setting, to bring up some problems associated with any linear or serial display system. The major problem encountered is that in normal Grade 2, as in special-purpose braille, nonlinear situations arise. In normal braille these situations include tables of contents, listings, and tables in general. Here, two-dimensional arrays are commonly used. Thus, a column of figures is tactually represented as a column. In mathematical[37, 38] and chemical[39] notation, it is common to encounter two-dimensional arrays displaying arithmetical calculations or chemical bonded structures respectively. Many of the above

structures have alternate linear forms or formats, but it must be recognized that these linear forms are *not* preferred.

There are alternatives to linear display within the context of our system. These would involve the incorporation of a stable two-dimensional array into the system as an option. In its broadest application, stylized figures or drawings could be presented in this array. The implication is that a 12-dot cell would be utilized (4 rows by 3 columns). A character presentation mode could be effected by lowering every third column and every fourth row of dots while retaining the potential of displaying figures.

Such display tableaux have been patented by Linville[40] and Sell.[41] The incorporation of an option of this type into the medium, and the required programming logic of the system present a relatively minor problem.

Certainly no board full of bumps can solve all display problems. It is thought that the appropriate solution in these cases, if not all cases, is to use embossed-braille addenda. Thus, embossed maps, picture brailling, and tables could occur on separate sheets included in a folder.

The indication of paragraph breaks is another problem to be dealt with. Two solutions present themselves: we can adopt the braille magazine convention of leaving three spaces to indicate a paragraph break,[3] or we can use the "ar" contraction twice, as does Krebs' shorthand.[42]

The analogous problem of footnotes can be avoided by standardizing their use. If we always use the so-called "Rule 22d," as described in the Instruction Manual,[1] and place the notes in a separate paragraph following the one in which the reference occurs, the difficulties can be avoided.

If we provide breaks via superdots we face the possibility of having to pad an inkprint line with encoded blanks which would be transmitted to the reader. These superfluous signals can be avoided by programming to eliminate more than three blanks in a row. A better solution extends the lead-out line to take up the slack created by the unnecessary characters.

ADDITIONAL CONSIDERATIONS

Since we maintain that the prepress costs of production are likely to be less in the inkprint situation, but cannot offer a firm rate comparison, we submit a comparison of the media costs. Using a figure of \$3 per ream[2] of press-braille paper and the previously introduced cost of under \$.005 a sheet for the inkprint medium, we can make a rough comparison sheet for sheet. APH's figure of 55,750,000 sheets pressed in the production of 620,000 volumes in 1971[43] justifies a factor of 1/50 of the media cost in our favor: 620,000 volumes would cost less than \$500,000 based on \$1 per volume.

The post office could afford to send four inkprint encoded volumes (sheets) with a press-braille folder in a manila envelope, first class, for less than one volume of press braille fourth class. Using a weight of three pounds and the current rates for fourth class mail, we arrive at a cost of from \$0.60 to \$1.35 to mail one volume. The manila envelope and its contents sent first class would cost less than \$0.30. The difference in delivery times alone could justify the use of first class mail. Moreover, the reader would receive the complete work at one time and not piecemeal over a period of weeks, as is now the practice.

Mauch[44] has provided valuable insight into the permissible cost of reading devices. Referring to character as opposed to braille readers he remarks that an upper limit to price must remain under \$2400. Our experience to date has led us to believe that a production cost of \$500 is easily maintained on 1000 devices.

SUMMARY

We have presented a fairly detailed description of a braille production system in which the key element is an inkprint medium. This medium can be optically scanned to drive a transducer which would act as an interface between the medium and a blind person.

Utilization of this medium compares very favorably with the use of embossed braille and cassette recording.

Using this system would allow the production of more titles in braille; the more timely delivery of titles, including periodicals and news publications; one-way mailing; and it would permit the blind person to build a private library.

The status of the optical reading device to be utilized is that of an incomplete prototype, and the medium has yet to be photocomposed. However, we have proved that the medium can be reproduced by normal printing processes and that a simple optical scanning device can read it. Also, we are in the process of creating photocomposed samples, and we will probably be demonstrating the completed page reader by the time this paper appears. A computer will be a necessary element in the hookup, but this is seen as an advantage rather than a drawback.

For demonstration purposes the output of the prototype will be a teletypewriter print-out and/or a single tactual cell.

CONCLUSION

It is difficult not to feel ebullient at the thought of being "God's gift to the blind." When we began, we had not yet schooled ourselves against overconfidence. Our experiences to date have put our thinking into clearer perspective. We now understand the obstacles that we must overcome, both without and within.

Nevertheless, we are confident that the proposed system could expand the horizons of the blind persons dramatically. If we may be permitted a polemical statement, it is hard to believe that in our affluent, electronic age, blind people must rely on chiselled monuments. It is even less reasonable that they should have to return them to the chiseller.

Our current plans are to proceed with the building of the page reader, using the PDP-8 as the necessary computational mechanism. Given promising results, we will press forward our search for a usable transducer while at the same time implementing the superdot facility. We also hope to put a programmable microcomputer into the prototype page reader. Incidentally, Tactual Horizons, Inc., will also be investigating the possibility of utilizing the input to the Grade 2 translator to produce a small form of large-print edition.

Finally, if adequate funding is available we foresee the production of prototypes for field testing within two years, and we look forward to reporting on our findings at that time.

ACKNOWLEDGMENTS

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APPENDIX

Parts List for Breadboard Optical Reader

Op Amp	MC1437P - Motorola	3 @	2.25	6.75
TTL NAND Gate	SN7400N - T. I.	1 @	.49	.49
TTL Hex Inv. O.C.	SN7405 - T. I.	1 @	.59	.59
NPN transistor	2N4123 - MOT	1 @	.39	.39
PNP transistor	2N4125 - MOT	1 @	.40	.40
FET transistor	TIXS33 (obsolete)	1 @	2.00	2.00
NPN Power Darlington	MJE 1100 - MOT	2 @	1.82	3.64
PNP Power Darlington	MJE 1090 - MOT	2 @	2.70	5.40
Diode, signal	IN914 - G.E.	4 @	.20	.80
Diode, zener 4.9v 1W	SZ4.9 - Schaur	1 @	1.26	1.26
Voltage regulator	LM309K - NSC	2 @	2.50	5.00
Rectifier diode	MR751 - MOT	4 @	.68	2.72
Power transformer	24-1 - Signal	1 @	6.99	6.99
Capacitor 4800MFD 25v	Sprague	2 @	2.30	4.60
Cap. disc 100PF 1kv	Sprague	5 @	.06	.30
Cap. disc 500PF 1kv	Sprague	1 @	.06	.06
Cap. disc .001MFD 25v	Sprague	2 @	.06	.12
Cap. disc .0033MFD 25v	Sprague	1 @	.06	.06
Cap. disc .0047MFD 25v	Sprague	5 @	.06	.30
Capacitor tantalum 2.2MFD 35v	DIT 2.2 - IEC	4 @	.70	2.80
POT 5k 1 turn	Spectrol	3 @	1.30	3.90
POT 20k 10 turn	Weston	1 @	1.30	1.30
POT 500ohm 10 turn	Weston	1 @	1.30	1.30
Motor 12v dc	9113BB-12	2 @	12.90	25.80
Resistor 1/4w 5% 510 ohm		2 @	.05	.10
" 1k		16 @	.05	.80
" 1.5k		5 @	.05	.25
" 7.5k		1 @	.05	.05
" 10k		8 @	.05	.40
" 13k		1 @	.05	.05
" 18k		1 @	.05	.05

Parts List for Breadboard Optical Reader (Continued)

Resistor 1/4w 5% 20k		1 @ .05	.05
" 51k		1 @ .05	.05
" 220k		1 @ .05	.05
" 240k		3 @ .05	.15
" 270k		2 @ .05	.10
" 470k		2 @ .05	.10
" 1m		2 @ .05	.10
Resistor 3 1/2w 3ohm	type BWH	1 @ .28	.28
Phototransistor	CTL4170 - Clairex	4 @ 3.23	12.92
Lamp, incandescent	222 - G.E.	2 @ .10	.20
Limit switch		2 @ 1.00	2.00
Terminal, female	Waldom-Molex	6 @ .02	.12
Terminal, male	Waldom-Molex	24 @ .02	.48
Terminal, male+female	Bead-Chain Mfg. Co.	24 @ .03	.72
Receptacle, 3 place	Waldom-Molex	3 @ .10	.30
Receptacle, 6 place	Waldom-Molex	2 @ .20	.40
Receptacle, 9 place	Waldom-Molex	1 @ .20	.20
TOTAL			$96.89

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A STUDY OF IMAGERY IN THE SIGHTED AND THE BLIND

William L. Dauterman

FOREWORD

Congenitally-blind persons and people who lose their sight later in life are faced with the problem of conceptualizing the physical environment with which they aspire to cope. Both the individual and the rehabilitationist have long struggled with problems related to methods of learning and teaching the development of functional modalities of imagery. While fortuitous imageries are encountered as the organism acquires experience and achieves creativity, it may *not* be assumed that all sighted and blind persons arrive spontaneously at an awareness of the importance of the cognitive use of imagery in the adaptation to and manipulation of the physical environment.

The understanding of imagery as it applies to the habilitation and rehabilitation of the blind is still at a very elementary level, but it is becoming an increasingly important subject for study and application. As a part of the development of a test of imagery ability of blind persons, the author undertook in 1968 to explore the literature. Theoretical constructs and practical applications were scrutinized and have been reported in the following pages.

The findings are reported in the four ways which seemed to provide the most useful and accessible forms for students of imagery and future researchers. The various schools of psychological thought were surveyed for their diverse approaches to the formulation of theory, experimental verification and practical application. The literature on blindness was reviewed for the same purposes and was found to yield fascinating conceptions and misconceptions, as well as a tremendous amount of verified data available for immediate practical application to rehabilitation. Tests and experiments offering potential value for research and application were reviewed and are reported in Part III under *Subjective Tests* and *Objective Tests*. The fourth presentation is the list of references which includes work actually cited in the text and some suggestions for further exploration where the material is peripheral rather than specific to the study of imagery.

The author, having been blind since 1929, obviously could not exclude his own experiences, perceptions and biases. In addition to his personal experiences with blindness, he supervised the Kansas Rehabilitation Center for the Blind for six years, taught at Texas Technical University for three years, Stanford University School of Medicine for eight and one-half years, and more recently was a counselor at Casa Colina Hospital in Pomona. The companion piece to this paper was also published by the American Foundation for the Blind in 1972 under the title, *Manual for the Stanford Multi-Modality Imagery Test.*

OBJECTIVE

The initial impetus for this study was the author's need to gain a knowledge of the psychology of imagery in all of the aspects which might apply to the development and standardization of an objective measure of imagery ability of blind

persons. In pursuing that goal it became evident that the relevant literature was vast and found in many professional fields. While there are a few publications which reported reviews of the literature on certain aspects of imagery, nothing was found which attempted to identify the broad scope of the subject as it might apply to both the sighted and the blind. Having found the research to be both very rewarding and time consuming, the author felt that the material should be made available in a convenient form for the use of future investigators who may wish to pursue one or more of the aspects he reviewed.

Considerable space is given to the early efforts to conceptualize the phenomenon of imagery. The evolution of thinking on the subject from philosophical musings to experimental psychology and related social sciences becomes evident. In that the subject is somewhat nebulous and the imagery experience highly subjective, it is not unnatural to find a dearth of information in the field of applied psychology. Much of the material presented was selected in the hope that it might have value for those who wish to pursue both pure and applied research. The sections dealing with imagery and blindness focus on both theoretical considerations and practical applications as they apply to the habilitation and rehabilitation of persons who are blind. Since the study of imagery is concerned with all sensory modalities and invades most of the subdivisions of psychology, a great variety of instrumentalities have been used to explore various types of imagery ability. An effort has been made to present descriptive data on a sizable sampling of experimental and standardized instruments which would appear to have significance for the measurement of imagery abilities. Some references are provided for investigators who wish to explore the literature beyond the concerns and scope of this work. The author's personal contributions are primarily observational and designed to stimulate other investigators to challenge his hypotheses through furthering the conceptual and empirical body of knowledge on imagery.

Part I

Gleanings from the Psychological Literature on Imagery

SOME THEORETICAL CONSIDERATIONS----AN INTRODUCTION

Among the earliest records of philosophical musings are references to imagery as a facet of thought process. No attempt will be made to present a comprehensive history of the theoretical and experimental work. Others have invested generously in that endeavor and it can be pursued by means of the accompanying bibliography. For an introductory overview of the subject, Osgood (1953) states:

> "The Greek philosophers had a great deal to say about images and ideas. In fact, they used the two terms more or less interchangeably. Plato, for example, argued that since an image looks just like the original object, but is smaller since it resides within the head, it must be a tiny replica of the original that enters the head through the eyes. Puerile as this notion may seem today, it must be remembered that the Greeks knew little about the nervous system. . . . But isn't there a real problem here? An image is a pattern of activity in nerve fibers. How can it 'look just like' an object? The problem is actually more apparent than real. What, after all, is the original *perception* of an object but a pattern of activity in nerve fibers? The fact that one's nervous process 'looks just like' another is not quite so surprising.
>
> "As a matter of fact, images are seldom exact duplicates of original impressions. What appears to be a perfectly recalled image proves, upon careful analysis, to be lacking in detail. Images are also reported as being less clear and less stable as well as less saturated than perceptions. . . . The major variables along which perceptions and various types of images range, however, seems to be that of *intensity*.
>
> "Some individuals, particularly young children, possess what is known as eidetic imagery. If the child is shown a picture for a few moments and then looks at a grey surface, a memory image is projected so clearly that he can literally count the number of spokes on a wheel or even read forward or backward the letters in an unfamiliar word. These eidetic images are not ordinary visual after-images; the child freely moves his eyes about exploring the object during the original impression rather than rigidly fixing a given point. One especially interesting characteristic of the eidetic image is that the individual appears able at will to focus upon any detail and make it gradually become clearer, the rest of the picture remaining obscure (Kluver, 1930). Another point worth noting, which relates this form of imagery to ego-involvement and other personality factors, is that the probability of the child's producing an eidetic image seems to depend upon the degree of interest in the picture (Allport, 1924). Despite the amount of work that has been done on the problem, however (see Jaensch, 1930, and Kluver, 1932, for reviews), the basic nature of eidetic imagery is unknown," (pp. 640-1).

Analytical psychology has emphasized the importance of symbols to the understanding of both the unconscious and the conscious life. The extensive studies dealing with the interpretation of dreams are essentially dealing with subjective experiences which are perceived and remembered images in one or more sensory modalities. Such images are thought to have symbolic meaning beyond their face validity and indicative of emotional states which are not yet available to cognitive manipulation during the individual's awakefulness. On the cognitive level the symbols are no less important since they are the basic

units of meaningful thought. The importance of imagery in the use of symbols is described in part by Spiegel (1959) who states:

> "Through various functionings involving symbols, we are enabled to relate conceptually to our several worlds. Within the psyche, by means of symbolic process, we transform experience into symbols, into hierarchies of symbols. Some of this symbolization goes on outside of awareness, the evidence of its functioning having been obtained through subtle observations in psychoanalysis and child study. In other words, symbolic process relates us conceptually to experience, even though some of the links are unconscious.
>
> "Symbols and symbolic activities function not only in the utilitarian exchange between persons but also contribute to the soaring reaches of the human mind, the building of constructs of thought and imagery which add to the culture. Symbols and symbolic activities, when pathic, bring down grave disorders in our personal life or even large-scale human tragedy.
>
> "Symbols enable us to think about an entity or phenomenon when it is absent or even intangible, and to conceive of the physically nonexistent. Symbols enable us to imagine. By means of symbols we express intricate states of being, we can exercise foresight, we remember and recall; that is, symbols serve us in the experience and functioning which are centered within us and also in our relatedness to others. The inner and outer worlds of symbolization communicate with each other. Our thoughts, dreams, and fantasies are often communicated to others; our symbolic activities in patterns of movement and behavior also speak.
>
> "Symbols may exist in the outer world and have outer form or concreteness, or they may exist entirely within us as an expression of symbol activity and process. The basic symbol modes of our inner life are *sense percepts*, *logical constructs* of thoughts, and *sense imagery*," (p. 913).

PERCEIVING AND IMAGING

Both philosophers and psychologists have argued for and against the unity of perceiving and imaging. The early psychologists spent much effort in attempts to arrive at satisfactory theoretical constructs which would explain one or the other view. Straus (1963) reviewed the subject and concluded that experimental evidence has satisfactorily supported the view that the processes of perceiving and imaging, while subjectively similar, are different phenomena. Sutcliffe (1964) found conclusive evidence from elaborate experiments supporting the findings of earlier experimentalists.

Contemporary psychology differentiates perception and imagery as two different mental phenomena which may at times be related. Perception is the process of giving meaning to or conceptualizing an experience, whereas imagery is alone an experience, the meaning of which is the subjective perception of the internal representation or symbol of an object or event.

Ruch (1958) defines perception in the following manner:

> "The process of perception stands midway along a continuum from sensing to thinking. In its purest, perhaps hypothetical form, sensing does not involve the use of learning based on past experience. Thinking, at the other end of the continuum, is independent of stimuli from physically present objects; it is accomplished through the use of symbols which represent absent objects and the relationships among them. *Perception* uses *both* the sensations aroused by stimuli and the learning gained from past experience.
>
> "Perception enables the individual to know where he stands in relation to the objects and conditions and people in his environment and to act accordingly.

Part of perception, of course, consists in determining the relationships between one object and another--but even this is done ultimately in reference to oneself. Terms such as *right, left, above,* and *below,* for example are obviously based on the individual's own position as a point of reference.

"In order for us to perceive an object, it is not necessary for all parts of it to stimulate our sense organs directly. When you look at a chair, for example, you cannot see all sides of it and perhaps cannot even see one of the legs; yet you see the chair as being *solid* and *whole*. Thus perception is a process of 'filling in.'

"An individual's ability to perceive a series of fragments as the whole object depends upon many factors. The intelligence of the perceiving individual and his mental set--that is, what he *expects* to see--are extremely important. So is past experience. . . . As a rule, the more intelligent a person is the fewer details he needs to perceive a whole.

"Our reaction to any situation is determined by the way we perceive it--not merely by the objective facts of the situation. It is quite possible that the same physical stimulus will be perceived in two quite different ways by two different people or even by the same person at two different times. On your 'good days,' for example, college and everything about it may seem very satisfying; but on 'blue Monday' your classes may seem dull, the food at the dormitory tasteless, and your friends irritating.

"Perception carries the conviction that what we see is a true representation of reality. Hence the old saying, 'Seeing is believing.' An *illusion,* or false perception, seems false only when we compare it with what we know to be true. To the uninitiated, a stick seen partly through water and partly through air does not just *seem* bent--it *is* bent," (pp. 265-6).

Thus for the purposes of this paper, imagery is the experiencing of a sensory representation which is conceptualized and therefore is perceived in a meaningful way.

Hallucinatory images are equally valid experiences which are perceived and are reportable, but the true meaning of which may be more on the symbolic level rather than being a representation of corporeality. The meaningfulness of the image is therefore spoken of as the perception of the experience.

AFTERIMAGES

It is important to keep in mind that the discussions cited here will attempt to exclude references to the phenomena of "afterimages." English and English (1958) define that process as follows:

"aftersensation: sense impressions or sense data, usually coming in rhythmic pulses, after stimulation of eye or skin has ceased. In vision, they are *positive* if the image is brighter than the surrounding field, *negative* if less bright. Usually, but not necessarily, the negative aftersensation is roughly complementary in hue as well; but in preferred usage negative and positive as applied to the aftersensation refer only to brightness relations. As aftersensations are of peripheral origin, that term is preferred to the somewhat more common *afterimages*, a term that suggests a central origin," (p. 16).

IMAGELESS THOUGHT

In spite of the obviousness and seemingly ever-present imaging process, Galton (1883) noted that some other scientists did not utilize images to the extent that he did, and in fact seemed to depend upon other symbols with which to implement *imageless thought*. Mathematicians have been cited as an occupational group who appear to be less dependent

upon visual imagery so far as their scientific pursuits are concerned.

Watson (1914) representing the developing school of experimentalists, espoused the thesis that thoughts, ideas, and images are merely implicit verbal responses. As an early behaviorist he crusaded against mentalism, and thus the idea of imageless thought was incompatible with his concept of thought as a form of verbal behavior.

Sartain et al. (1958) indicate that the stimulus field seems to have a great deal to do with the amount and type of imagery which will be utilized in various thought processes. They also comment on images functioning as symbols but that all symbols need not be images.

IMAGERY AND THE "STIMULUS ERROR"

It is evident that the *entity concept* of imaging has been replaced by the *processing concept* which accounts for many of the characteristics of sensation associated with imagery. However, Sutcliffe (1962) reminds us that Titchener's notion of the *stimulus error* is relevant in that it is important not to confuse attributes of a stimulus with features of the process of imaging. Thus, spatiality and color are characteristics of objects of knowledge rather than the process of imaging (pp. 191-2).

IMAGES VERSUS SENSATIONS

Apparently individual differences between the strength of perceptions and sensations have led philosophers and psychologists to different conclusions as to the true nature of images. Sutcliffe (1962) reviewed and discussed at length the two major points of view:

> "The notions, idea and image, have long been objects of philosophic study. Early controversy concerned itself with whether there was a qualitative difference between sensation and image, or just a difference in degree. . . some argued that presentations and their revived images differed only in degree of texture of intensity. Others held that images and sensations are *toto genere* different, and therefore, incomparable things," (p. 187).

As supporting the position that images are comparable with sensations in various ways, such as texture, fleeting, incompleteness, indistinctness, intensity, liveliness, forcefulness, Sutcliffe cites Bain (1855), Baldwin (1890), Ebbinghaus (1897), Hobbes (1650), Hume (1739-40), James (1890), Kuelpe (1902), Lotze (1852), Mill (1829), Titchener (1909), and Wundt (1897) (p. 188).

On the other side of the controversy Sutcliffe (1962) says of Ryle (1955), Sidis (1904), Stout (1929), and Ward (1918):

> "To these thinkers the sensual vivacity characteristic of every sensation just does not belong to the idea, not even in a diminished intensity. Sidis (1906, p. 250) wrote, . . . (one must reject). . . the untenable position that ideas, no matter how intense and vivid, can ever become sensations, or percepts," (p. 189).

Sutcliffe concludes,

> "The first view seems to uphold the doctrine that images are faint copies of sensation: images are to be identified with sensations in quality although they may differ in texture or intensity. The second view regards the difference between the two as one of nature: image and sensation cannot be identified with one another, they are two different things. . . . Similarly one either sees or not and if one sees one does so with a certain clarity; but the vividness of imagery is not the same as the clarity of perception, nor does it differ from it merely in degree," (pp. 189-208).

HALLUCINATORY IMAGERY

The literature dealing with hallucinogenic drug usage is extensive and records both primitive and sophisticated societies' employment of chemical agents to induce abnormal

states of consciousness in which imagery seems to be a predominant factor. The current proliferation of drug usage has brought forth a great deal of public interest, theoretical discussion, and more than usual scientific attempts to investigate the neurological as well as psychological aspects associated with aberration of imagery. Most importantly, the use of such drugs, dating back before recorded history, would seem to indicate an extremely prevalent interest in the possibility of exploiting imagery as well as other psychic phenomena beyond their normal function. Such exploitation presumes that the capacity to image is a highly valued human attribute which may seem to hold the potential for transcending normal experiences and for the penetration of the unknown. To take a single example, Leary, Metzner, and Alpert (1964) successfully popularized the use and the investigation of LSD. Subsequently, subjective reportorial theses have given way to scientific endeavors to discover how this and other drugs actually work.

Debold and Leaf (1967) discuss two theories:

> "1. Excitatory and inhibitory synaptic interactions occur at all subcortical and cortical stations in a projection pathway. Thus LSD-induced blockade or activation of one or another synaptic site can lead to profound disorganizations of the temporal and spatial patterns of impulse activity in the projection pathway. . . .
>
> "2. It is now an established principle of neurophysiology that complex control systems are continuously in operation in shaping, blocking, or facilitating one or another channel of sensory information, and that this regulation of sensory input to the brain is variable under different conditions of sleep and wakefulness. Such mechanisms for controlling afferent input not only permit focusing of attention to a particular task or motor event, but also protect the brain from the cacophonous interplay of the varied meaningless signals that continually bombard sensory receptors. Recent neurophysiological investigations indicate that much of the control of sensory input to the brain is regulated by projection pathways from nonspecific 'reticular systems' to primary sensory neurons in the spinal cord and brain-stem. Little imagination is required to envision the consequences of disturbances initiated by LSD in these 'reticular systems,' hence the emphasis placed here on those experimental studies that have suggested a major action of the drug on brain-stem reticular regions. For it is within these complex brain-stem networks that much of the synaptic business of integrating incoming and outgoing information is transacted, and it is here that LSD is most likely to cause profound physiological disturbances through its synaptic actions," (pp. 181-2).

These authors also seem to support the idea of parallelism of the sensory modalities when they conclude, "the same undoubtedly holds true for LSD-induced disturbances in auditory, olfactory, gustatory, and somatic sensations." In addition to the chemically induced hallucinations, the great variety of psychopathological phenomena have been of interest for the insights they might shed on the normal functioning of imagery, but are not germane to this discussion.

DEVELOPMENTAL MANIFESTATIONS OF IMAGERY

Jaensch (1930) makes some rather definitive statements concerning the developmental aspects of eidetic imagery in the visual mode based on experimental investigation and intercultural observations:

> "Although the disposition for eidetic images, even in their more pronounced forms, is widely prevalent up to puberty, we must not expect to find the same, or even approximately the same, percentage of eidetics everywhere. In this respect the greatest differences exist between one locality and the next, and in the same place between different classes in a school. The eidetic disposition

is correlated with certain constitutional types, whose distribution varies from locality to locality, and this explains the variation in the frequency of pronounced eidetic cases. Far more fundamental, apparently is its dependence on the type of education, in particular on the difference between the old school and the new.

". . . There is no contradiction between these facts and dependence on the constitution, which was mentioned above. For children that grow up under these conditions are not only different in respect of educational aims; they also show characteristics connected with the eidetic constitution, which are in no way intended by their particular education. In the case of such children, we have to postulate a youthful organization that is determined by these influences, or rather, preserved and guarded by them. Furthermore, the connection between eidetic disposition and general constitutional structure has to be acknowledged, because these favorable conditions are not usually present. Those individuals will therefore prove to be eidetics of the more pronounced type, whose constitution is most favorable to this mode of experience and gives rise to eidetic phenomena in spite of the resisting factors that are usually present," (pp. 9-10).

Another area of vital interest, but one which has received less attention, is that of the developmental aspects of integrated processes which are assumed to be vital to the understanding of imagery as an aspect of the thought process. Birch and Lefford (1963) attempted to identify and measure certain facets of information integration in children of five through eleven years of age. Using selected geometric figures from the Seguin-Goddard Formboard, subjects were exposed to the stimuli in a paired comparison series utilizing three modalities, visual, kinesthetic, and haptic. While at no time did the authors utilize the term *imagery*, it is assumed that the subject must form an image of the initially perceived stimulus in one of the three modalities in order to arrive at a judgment as to whether the form perceived through an alternate modality is the same as, or different from, the original form. If this assumption is correct, the experimental evidence would support not only the developmental aspects of generalized integration but also the specific developmental aspects of the ability to form and utilize images in at least the three experimental modalities employed. Their conclusions are summarized in the following findings:

"1. It was found that the ability to make the various intersensory judgments clearly improved with age. The improvement in function appeared to be adequately described by a typical logarithmic growth curve which supports the view that the development of intersensory functioning follows a general law of growth.

"2. It was found that, for both judgments of identical and nonidentical forms, the least number of errors was made in the visual-haptic judgments.

"3. In the judgment of identical forms, visual-kinesthetic judgments and haptic-kinesthetic judgments were of the same order of difficulty.

"4. In the judgment of nonidentical forms, the haptic-kinesthetic judgments tended to be somewhat less difficult than the visual-kinesthetic judgments.

"5. By the eleventh year, there appeared to be a minimum of errors under all the conditions of the experiment.

"6. It was also noted that differences among the subjects in the ability to make correct intersensory judgments tended to decrease with age.

"7. It was found that, by age five years, over 50 percent of the subjects were making two or less errors in intersensory judgment under the conditions of the experiment. This indicates that some aspects of intersensory judgments are well

developed by school entrance age. However, full effectiveness in the utilization of intersensory information is not reached until a later stage of development.

"8. It was found that it was generally more difficult to make intersensory judgments of identical forms than intersensory judgments of nonidentical forms.

"9. When the results of the 22 left-handed children were analyzed, it was found that there were no significant differences in performance made with the preferred hand as compared to the nonpreferred hand.

"10. When the results of the total group were considered, it was found that there was a tendency for fewer errors to be made with the preferred hand under all conditions. When judging identical forms, it was found that fewer errors were made when the nonpreferred was utilized.

"11. Girls were found to make significantly fewer errors than the boys at three age levels under various conditions of the experiment. The findings, however, do not warrant any generalization about relative superiority.

"12. It was found that, for all conditions of the experiment, the diamond and hexagon were the two most difficult forms to judge, and the circle and star were the two least difficult forms.

"13. It was found that the rank order of difficulty in the ability to judge the various geometric forms was quite stable from age to age and under the various conditions of the experiment.

"14. The effect of the pairings of the different geometric forms on intersensory judgments under the various conditions was analyzed. It was found that both the pairings of the geometric forms and the intersensory modalities involved affected the errors in judgment made by the subjects.

"15. In order to evaluate the intersensory effects as independent from the intrasensory effects, an analysis was made of intrasubject response patterns. It was found that the chief developmental findings were reconfirmed. These findings were discussed with respect to the development of intersensory functioning and its relation to adaptive capacity," (pp. 45-6).

Michael (1966) in an unpublished dissertation reports a study of fifty third-grade and fifty sixth-grade students to determine the existence of a visual imagery factor, of an auditory imagery factor, and of a kinesthetic imagery factor. With the exception of Robbins and Robbins *Test of Non-Verbal Imagery*, the fifteen standardized aptitude tests utilized in the study have only presumptive value as measures of imagery for the modalities cited. She concluded, "The factor defined as Visual Imagery was found to be present in the total population, and remained stable in the Caucasian, Negro, and female populations," (p. 123). Although twelve other factors were defined along with six additional undefined factors, her only relevant conclusion was that the factor defined as *visual imagery* was not found in the male population or when the population was divided as to grade level. This study does not contribute to our understanding of developmental aspects of imagery ability but does demonstrate the difficulties to be encountered in the design of pertinent research.

Birch and Lefford (1967) pursuing other facets of the developmental process (which, however, seemed specifically concerned with visual stimuli, selective perception, and motor activity) found further supporting evidence indicating that integrated processes developed rapidly in normal children and tend to level off at what might still be considered an early age. While their conclusions say nothing about practice effects that might be accumulative by adulthood, the findings do appear to confirm that the measured abilities are well developed before the onset of maturity:

"1. The children studied showed an increasing ability, with age, to integrate afferent information deriving from different sense systems. We have viewed this improved ability to treat such multimodal information as equivalent as reflecting the development of improved patterns of intersensory integration and as representing a fundamental change in organization of afferent processing with age.

"2. Children ages 5-11 improved in the ability to deal with differentiated aspects of visual stimuli. They were able, with age, to shift from a tendency to respond to the figure as a whole to facility in fragmenting the whole figure, in identifying subwholes and in combining and reorganizing for the purpose of reconstructing the whole figure. With age, the visual perception of form became flexible and selective, and in this sense, increasingly differentiated.

"3. Concomitantly with the changes in his afferent processing, the child improved in his ability to organize his actions so that the product of his action replicated a visually presented model. Moreover, as he grew older, the child became increasingly capable of treating ancillary visual information as a facilitator rather than as a distractor in motor performance," (p. 79).

Birch's hypotheses and findings were based on studies of normal subjects, whereas, Juurmaa (1967) studied blind subjects and found significant developmental differences:

"A person with normal sensory functions experiences the sense qualities specific to various sense modalities as constituting a common, heterogeneous material. Sometimes a perception is based principally on visual and sometimes on tactual impressions. There are instances where it is difficult to say whether we recognize the thickness, smoothness, or roughness of an object better through vision or through touch.

"The last point is directly connected with the question concerning the recognition of form through the touch sense: in the absence of the integrating function of vision, the blind, and, notably, the congenitally blind, utilize touch in a manner that is different from the way the sighted use it. In the light of the study of sensory deprivation it appears that when any one sense is nonfunctional, this also affects the perceptions based on the other sense departments. . . . Gomulicki's (1961) investigations suggest that the congenitally blind do not attain the level of the sighted in many relatively simple tasks based on touch and hearing until the age of 15 or 16. Perhaps it is not until that age that the blind have learned to develop effective strategies for an adequate appraisal of the information mediated by the senses. In the sighted, as we have seen, vision is of assistance in appraising information gained through the other senses too. Presumably, if a sighted person were compelled to rely exclusively on tactual images--that is, if it were possible to deprive him of visual imagery altogether--it would take him a great deal of time to develop effective modes of sensory functioning, and it would also take time to learn to appraise the information thus received," (pp. 17-8).

Analytical psychology has much to offer toward the understanding of the development of the congenitally blind child. No effort is made here to restate the theoretical constructs regarding normal development. However, Sandler (1963) makes some highly pertinent statements regarding the interference of blindness in the developmental process based on Freudian theory and clinical observations.

"The hypothesis which will be elaborated here is that practically from the very beginning, because of the absence of a major sensory modality, the ego development of the blind child will tend to proceed along different lines from that of the sighted. The

present study is based on the premise that the ego development of the blind child is hindered or distorted by his sensory handicap. To understand the blind child at any age necessitates taking into account the whole history of his development. Thus the peculiarities and limitations of the blind have to be assessed in terms of (a) their present sensory defect, and (b) the effect on their progressive development of their having been blind from birth," (p. 344).

"In conclusion, there appears to be evidence that all children blind from birth show a degree of fixation to the very earliest phase of development, in which the passive experiencing of bodily gratification is dominant. The degree to which progress toward mastery of the external environment can be made will be a function of the degree of skill shown in the maternal care which they receive, but it seems highly probable that the basic pull toward self-centeredness and the modes of gratification characteristic of the first phase of life will always be present," (p. 359).

While the imagery phenomena is not discussed, it should be noted that the turning in of the focus of the emotional and cognitive processes is essentially an inability to cope with the external world to the extent possible with sight. Thus the ability to utilize energy, in whatever sensory modality, can be assumed to be retarded developmentally and impoverished by experiential limitations. This does not preclude the development of highly specialized and superior imagery ability in certain modalities in which the blind child has the necessary physiological capacities and environmental stimulation.

Thus we have considerable experimental evidence, as cited above and elsewhere, supporting the theoretical position that imagery abilities in the various modalities follow much the same developmental patterns as do other human characteristics. Constitutional or physiological factors, cultural differences, generalized environmental factors, sensory deprivation, and specific training or educational experiences will all tend to contribute to a normal distribution of imagery ability in the population as a whole and around a mean for homogeneous groups.

TYPES OF IMAGERY

Osgood (1953) concludes that there are marked individual differences in imagery ability and the modalities in which they are most proficient. He cites Beethoven's ability to compose by utilizing auditory imagery long after total deafness had overtaken him, and Emile Zola's portrayal of olfactory imagery in his writings.

It is therefore evident that psychologists have hypothesized the existence of memory phenomena in the other sensory modalities, which phenomena are comparable to visual imagery. A clear statement indicating the acceptance of parallel forms of the imagery experience is set forth by Sartain, North, Strange, and Chapman (1958)--

> "So familiar are visual images that we tend to underestimate the frequency and importance of other kinds of imagery. It is true, however, that most of us also have auditory images, such as that of a melody, and also images corresponding to some of the other senses, such as touch, pressure, and temperature. We can imagine a feather brushing our cheek, or pressure on our chest, or shivering in a cold wind. Many of our images are actually blends or composites of images in various sensory modalities," (p. 263).

For the purposes of this review much of the literature under the general classification of "imagery" is excluded since it is assumed that the memory images utilized in cognitive processes are eidetic images as lucidly defined by Sartain, et al. (1958) as:

> "Some people have an extremely vivid kind of visual imagery known as *eidetic* imagery. After a person with eidetic imagery has been shown a picture for a few seconds,

he can name and draw most of the details. He is said to have a 'photographic memory,' since his memory image has detail something like that of a photograph. Such a person may be able to study a page of technical material for a few moments and then recite it simply by reading from a visual image of the page. As in all other extremes of performance, persons with eidetic imagery simply differ in degree from other people in the vividness of their visual imagery. At the other extreme are people who have only the faintest of visual images," (p. 264).

Various attempts have been made to differentiate types of imagery. Sutcliffe (1962) finds the following breakdown appears most frequently in the literature:

1. After-images, described as after-sensations, occurrence conditional upon quite particular stimulation, and the phenomenon a direct continuation of the perceptual processes after the removal of the stimulus.

2. Eidetic images possessing a pseudo-perceptual nature, a special kind of memory image, content may be altered by an act of will, having the "out-there" quality also characteristic of the after-image and characterized by extreme vividness.

3. Hypnagogic imagery, belonging to any sense mode, autonomous, occurring in the drowsy state prior to sleep, and often characterized by highly colored, detached, quickly moving images.

4. Hypnopompic imagery, occurring in the drowsy state between the end of sleep and waking up, with considerable autonomy and not easily controlled by the subject.

5. Memory image, filmy, colorless, slowly developing, liable to continuous change, lasting but a short while, and involving eye movements.

6. Image of imagination, substantial, vividly colored, presenting itself at once, stable and persistent, and involving steady fixation.

The earlier authors began to think about imagery as dichotomous. Galton (1883) was concerned with imageless thought and visual imagery. Betts (1909) spoke of *voluntary imagery* as the ability to call up certain specified images at will, and *spontaneous imagery* as the normal function of imagery in mental processes. These now seem to be oversimplifications of phenomena which subjectively appear dichotomous but upon further investigation are much more complex.

The literature, naturally, deals primarily with phenomena related to visual imagery since that form of imagery appears to be dominant, pervasive, and the product of the most integrating sensorium available to normal subjects. However, the exclusive use of the concepts associated with the notion of eidetic imagery does not seem to be necessary nor correct usage. Having granted the presence of individual ability differences, it is understandable that less accomplished musicians still utilize auditory imagery to assist them in the recall of music even though hearing is still available to them and the creative product or resulting behavior does not reach the perfection of Beethoven's compositions. Juurmaa (1967) elaborates on this theoretical position:

> "General psychology is interested in the laws governing the various sense departments. The corresponding problems of applied psychology relate to inter-individuality in the sensory and perceptual functions associated with various sense departments and to the relationships of this variability to the other psychic functions. An alternative formulation of the last question would be: How do certain mental functions depend on various sense departments? Are any analogies ascertainable among mental functions tied up with different sense modalities, and can such functions be replaced by another?

"The psychic functions associated with the haptic sphere can be considered along two principal lines. First, attention may be focused on interindividual differences in the sensitivity to stimulation of the cutaneous receptors. Second, the interindividual differences in form recognition and the structural gestalting processes may be studied. The problems associated with interindividual differences in the stimulus and difference thresholds have been referred to; and they will not be considered here in greater detail. It should be pointed out, however, that complex functions such as, say, form recognition, may be assumed to take place rather independently within certain limits set by the modal sensitivity.

"Before discussing the central problem--that is, the problem of form recognition without the assistance of vision--a few theoretical points of view will be touched upon. . . .

"The qualities that, in principle can only be perceived through vision outnumber by far the qualities that can be perceived exclusively through touch. Still more important, the associative perception of qualities belonging to the tactual world through vision is possible far more frequently than the associative perception of visual qualities through touch. The roughness of a surface, for example, can be seen as well as felt. . . . The poorer a sense modality, the scantier is the vocabulary used to describe the attributes related to it. A good example is provided by the touch sense: the number of immediately comprehensible adjectives--such as, say, rough, smooth, and so on--is very small," (pp. 16-7).

Revesz (1950) elaborates at great length on the psychological problems, yet unsolved, relating to the differentiation between visual and haptic experiences. He points out that the field has been plagued by the concepts associated with vision and he calls that general approach to the problem of haptics *visual haptics* or *optohaptics*. He feels that the two spheres are phenomenologically different and admits that the confusion is understandable because of the subjective prevalence of the optic experience among investigators who have naturally, if not correctly, thought of the haptic experience of space as merely a different way of perceiving the same thing. He points out that the stimulus qualities of the visual and haptic worlds are different and cannot be experienced through the various sensory channels without resulting in differential psychic phenomena. Further, he concludes the visual and haptic spheres are not only phenomenologically heterogeneous because the stimulus qualities differ but also because the perceiver is innately organized to function in a differential manner. Learning to organize space into meaningfulness, he grants, is a necessary part of developing perception and conceptual spatial relations. Learning takes place through the various sensory modalities and only later can be translated from the visual to the haptic modality or from the haptic to the visual modality as a verbal analogy rather than a transposable homogenetic phenomenon.

White et al. (1970) present some striking evidence which indicates that there may be much more functional equivalence between the various sensory modalities than Revesz allowed. Using a television camera as a sensor and a 400-point tactile matrix in contact with the skin on the back of the subject, the "visual substitution system" was used by sighted and blind subjects to identify two- and three-dimensional objects, singularly and in combination, in motion, or situated so that the perception of depth was measurable. Although the work was very carefully done, the authors freely apologize for the technical limitations present in the original experimental equipment. Their most enlightening contributions to the future understanding of the nonvisual perception of objects in space are well stated in the following:

". . . The most striking feature of the initial results with the system is that Ss, blind and sighted, are able, after only relatively short training periods,

to identify familiar objects and to describe their arrangement in depth. . . . Evidently even a crude 400-tactor system is capable of providing sufficient information to permit construction of what is usually called the visual world.

". . . It is clear from these first tests with the visual substitution system that three-dimensional organization of the information in the dynamic tactile array is easily achieved.

". . . With fixed camera, Ss report experiences in terms of feelings on their backs, but when they move the camera over the displays, they give reports in terms of externally localized objects in front of them. The camera motion here is analogous to eye movements in vision and this finding raises the interesting possibility that external localization of percepts may depend critically upon such movements.

"It is at least a plausible hypothesis that a translation of the input that is precisely correlated with self-generated movement of the sensor is the necessary and sufficient condition for the experienced phenomena to be attributed to a stable outside world. The converse of this hypothesis should also hold--that a lack of correspondence between a translation of the input array and self-generated sensor movements should result in experiences that are attributed either to nonrigid conditions in the external world, or to phenomena that have their perceived origin within the observer.

". . . Thus far there have been no salient differences between the blind and the sighted Ss in their acquisition of skill on this visual substitution system. As was mentioned previously, the relationship between visual angle subtended by an object and distance from the S is one that the blind have not experienced directly and thus have to be introduced to as a 'cue' for distance.

". . . The learning seen thus far is certainly not of the prolonged sort postulated by Hebb in initial visual form discrimination. Nor have there been marked differences between the congenitally blind and sighted Ss, which might also be expected by empiricists like Hebb or Taylor (1962). Also, the results do not lend support to a theory of visual form perception that postulates highly specialized feature detectors at the retinal level, though the drastically impoverished display in the present tactual system makes any conclusions in this regard only tentative.

". . . It would be rash to predict that the skin will be able to see all the things the eye can behold, but we would never have been able to say that it was possible to determine the identity and layout in three dimensions of a group of familiar objects if this system had been designed to deliver 400 maximally discriminable sensations to the skin. The perceptual systems of living organisms are the most remarkable information-reduction machines known. They are not seriously embarrassed in situations where an enormous proportion of the input must be filtered out or ignored, but they are invariably handicapped when the input is drastically curtailed or artificially encoded," (pp. 25-7).

While the first authors cited established the principle of imagery phenomenon associated with each sensory modality, Juurma, Revesz, White, et al. are preoccupied with the problems of sensing and perceiving via the various modalities. Having accepted sensation as a precursor to perception, whether or not the processes are direct the retention and recall of percepts apparently falls into the sphere of imagery. The acquisition of new perceptions through whatever modality must necessarily be related to the subject's ability to refer to previously acquired perceptions which are available to him symbolically in the form of simple or complex, single- or

multi-modal images. Having established this position as a theoretical construct, experimental evidence and clinical performance must also recognize the principle of individual differences in the formulation of expectations for actual performance of the activities in daily living.

VERBAL IMAGERY AND ITS INFLUENCE ON OTHER MODALITIES

In this context *verbal* pertains to words used in any form: spoken, heard, seen, written, or thought. Included in verbal behavior are both producing and responding to words as defined by English and English (1958). At least from the time Galton became interested in differential thought processes the question of strictly verbal thought, with or without word images, has been an issue in numerous theoretical constructs and experiments designed to illuminate the subject of imagery. In this relationship words seem to take on the characteristics of symbols and are usually considered highly subjective. This theoretical position, which diverges from that of several earlier theoreticians, is well stated in the work of Carmichael, Hogan, and Walter (1932) who concluded :

> "1. When a meaningful word is heard by an individual, some process within his organism is initiated which presumably includes receptor activity, neural activity, and effector response. This activity includes the activity of those processes which are held by some psychologists to be the correlates of the introspectively known states of imagery or symbolic representation. These physiological processes are, if the theory be accepted, in part the result of present sensory stimulation, and in part the result of the education of activity and experiences that would not be as they are save for the past experience of the organism.
>
> "2. When a visual (or, indeed, any other sensory) pattern is perceived by an individual, it may likewise be assumed that certain processes within the organism are initiated which include activities similar to those considered above, but which are in some measure correlated with the given visual experiences.
>
> "3. The present objective experimental results seem to show that in many cases the recall of a visually perceived form is altered by the fact that a particular word is said immediately before the visual presentation of the form.
>
> "4. Without the use of additional terms, therefore, it seems that if a subject has just heard, for example, the word 'eye glass,' certain processes in his organism have been started that initiate certain processes which are possible because of the past experience of that individual with *eye glasses* as words and as objects. If, while these processes are in progress, a figure of two visual circles connected by a line is presented to the subject, this figure may later be reproduced in a different manner than as if the processes present in the individual at the time of the same visual presentation had been evoked by the word 'dumbbell.' In other words, without recourse to any elaborate theory, one who wishes to make an empirical statement of fact may say: If a verbal stimulus-form and a visual stimulus-form are presented to a subject in certain temporal relationships, the processes in question may be modified, or rather a new total process may result, which is in certain respects unlike either of the previous sets of processes. On subsequent arousal by any 'part' stimulus the 'reproduction' is thus a complexly determined total, and not either of its component processes.
>
> "Thus, as is so often the case, phenomena that are said to be explained in the verbal terms of the configurational theory may at least tentatively

be described in terms of a dynamically considered process of association," (pp. 84-6).

In their discussion of their results and theoretical interpretation of experiments in which the effect of verbal suggestion in the recall period upon the reproduction of visually perceived forms, Hanawalt and Demarest (1939) stated:

"Certainly the trace which is the basis of a figure constructed in recall is a more complicated structure than the simple 'neural engram' of a photographic-like perception of a figure or form. On the basis of the experimental results, a reaction theory of reproduction seems to be forced upon us. O has a task to perform--the task of constructing a figure which has been reacted to in a certain situation in the past. He may remember that the figure looked like some object, or remember some verbal analysis made during the study of the figure. He may remember, too, some of the exceptions which kept the figure from being an exact representation of the associated object. There are details which were not reacted to specifically in perception hence these have to be produced in construction. The task of construction is likely to be accompanied by some verbalization more or less like that which occurred in the learning period. His construction is based upon these learning reactions, these reactions in recall, and a general knowledge and experience with figures.

"Verbal suggestion in recall in the present experiment appears to operate in several ways as an aid in this construction. In many cases the suggestion enables O to contact the trace of the figure and the learning verbalization. If he remembers the latter vividly he may disregard the suggestion in recall. On the other hand, if the learning association is indefinite, he may depend to a great extent upon the suggestion to fill in the unclear characteristics of the trace. Often the influence of both the learning association and the suggestion in recall is evident. With increased delay in construction, the suggestion in recall operates more and more as a factor in the production of the figure," (pp. 172-3).

Utilizing conventional visual stimuli both with and without "labeling" Bruner, Busiek, and Minturn (1952) arrived at the following conclusions:

"The effect of instruction or labeling prior to the input of a stimulus-to-be-perceived is to increase the likelihood of the categorization of the percept as having a particular identity. Identifying a figure is a matter of relating it to a category of objects. Any given category of objects may be conceived to have an adaptation level or, in other terms, a 'typical instance.' Where stimulus input is inadequate--in the present case, made so through brief exposure--the resulting percept will be assimilated toward the typical instance of a category. The same processes may operate in memory: assimilation being a systematic change in the 'memory image' in the direction of typicality. Any reduction in stimulus determination, through reduced stimulus adequacy or through an alteration of forces of organization in a memory trace, will bring about this effect," (p. 155).

The concept of spatiality in verbal processes is hypothesized and developed by Bonkowski (1967). In experiments with normal and unilaterally brain-damaged subjects, he demonstrated the function of the nondominant hemisphere of the brain in spatial perception. Spatiality, rather than exclusively temporality, is hypothesized to be an extraverbal component in all verbal processes. While verbalisms are usually thought of as temporal in the auditory modality, it is evident that spatial orientation is commonly a part of verbal perception and memory in the visual modality. Bonkowski interprets the concepts as follows:

"It is assumed that there are extraverbal as well as verbal components in the spoken as well

as in the written language, and that these components are affected differently in humans with lateralized brain damage, dependent upon which hemisphere is damaged. The verbal component refers here to the meaning or symbolic function of words. It is suggested that one extraverbal component is related to the spatial characteristics of language.

"At the level of first-order sensory neurons, the spatial characteristics of the spoken language may be provided by the patterning of sound waves, just as the spatial and temporal pattern of radiant energy provides the spatial characteristics of the printed language.

"In terms of the external stimuli, the spatial characteristics of the printed language refer to the orientation in space of letters and words. In analogous fashion, perhaps it is the phonemic structure of words that provides a spatial characteristic of the spoken language. For example, if the words *pit* and *tip* are present aurally and the listener asked to differentiate them, it is the arrangement of the phonemes that becomes crucial in making the discrimination. It may be argued that phonemic arrangement is a temporal rather than spatial factor. Whatever the case may be, an analogous situation exists in both perceptual modalities, and the spatial characteristics of written and spoken words comprise an extraverbal component of language.

"The difference in function of the cerebral hemispheres provides an opportunity to test certain assumptions related to verbal and extraverbal components of language. It is generally agreed that the left (or dominant) cerebral hemisphere governs certain aspects of language acts, and these appear to be related to what has been referred to here as the verbal components. The right (or nondominant) hemisphere is more important in dealing with spatial relationships (cf., Penfield and Roberts, 1959) and should therefore be more important in governing certain extraverbal components of language acts," (pp. 558-9).

From the foregoing it becomes obvious that imagery, like other mental processes is far from an isolated phenomenon. Rather it is the result of a complex of past experiences, emotionality, motivations, and anticipations, interacting and synthesized in a dynamic process. It is characterized by a high degree of subjectivity and individuality akin to, and comparable with, emotions. Since language is pervasive and powerful as a stimulus modality, verbal influences of any kind are presumed to have a strong influence on imagery formation and their cognitive and emotional meaning to the individual.

MEMORY AND IMAGERY

From the foregoing elaboration on the types and modalities of imagery, it appears evident that there is demonstrable unanimity regarding the role of memory. Further, images do appear to deviate from percepts and are the residual, modified, synthesized, and manipulated products of past experiences. Not only is there a lack of experimental evidence, but there is an absence of theoretical constructs supporting the occurrence of images completely disassociated from the past experiences of normal subjects under normal conditions.

Sartre (1966) postulates four characteristics of the image as follows:

"1. The Image Is A Consciousness

> . . . the object of the image is not itself an image. Shall we say then that the image is the total synthetic organization, consciousness? But this consciousness is of an actual and concrete nature, which exists in and for itself and which can always occur to reflection without any intermediary. The word image can therefore only indicate the relation of consciousness to the object; in other words, it means a certain manner in which the object makes its appearance to consciousness. . . ."

"2. The Phenomenon of Quasi Observation

. . . To perceive, conceive, imagine: these are the three types of consciousness by which the same object can be given to us. . . . In a word, the object of the perception overflows consciousness constantly; the object of the image is never more than the consciousness one has; it is limited by that consciousness: nothing can be learned from an image that is not already known. . . .

"3. The Imaginative Consciousness Posits Its Object as Nothingness

. . . All consciousness is consciousness *of* something. . . .

"4. Spontaneity

The imaginative consciousness of the object, as we noted above, is not sure of itself. This consciousness, which might be called transversal, has no object. It posits nothing, refers to nothing, is not knowledge: it is a diffuse light which consciousness releases for itself, or, to drop analogies, it is an indefinable quality which attaches itself to every consciousness. A perceptual consciousness appears to itself as being passive. An imaginative consciousness, on the contrary, presents itself to itself as an imaginative consciousness, that is, as a spontaneity which produces and holds on to the object as an image. This is a sort of indefinable counterpart of the fact that the object occurs as a nothingness. The consciousness appears to itself as being creative, but without positing that what it has created is an object," (pp. 4-17).

It is evident that an understanding of how memory actually occurs will be necessary before imagery in memory can be understood. Progress is being made by workers in several disciplines, but the findings are far from complete and only poorly understood by intradisciplinary investigators. While psychologists are essentially concerned with the behavioral manifestations, both in normal and abnormal subjects, the awareness of physiological bases of the memory process would appear to be an essential precursor to applied psychology. Pribram (1967) attempts to review his own work and that of colleagues in the field of neurophysiology in an effort to bring together current findings in his field and some of the behavioral manifestations. Writing in *Scientific American* he says in part:

"In 1950, toward the end of a busy life devoted to investigating the neurophysiology of memory, Karl S. Lashley wrote: 'I sometimes feel, in reviewing the evidence on the localization of the memory trace, that the necessary conclusion is that learning just is not possible at all. Nevertheless, in spite of such evidence against it, learning does sometimes occur.' That same year Edwin G. Boring, a leading psychologist of Lashley's generation, pointed out the deep impact that this failure to find physiological evidence for the memory trace had had on psychology. 'Where or how,' he asked, 'does the brain store its memories? That is the great mystery. How can learning persist unreproduced, being affected by other learning while it waits? On the proper occasion what was learned reappears somewhat modified. Where was it in the meantime? . . . The physiology of memory has been so baffling a problem that most psychologists in facing it have gone positivistic, being content with hypothesized intervening variables or with empty correlations.'

"Hardly were these bleak observations in print before new research tools became available and were promptly applied in experiments on the neurophysiology of memory. As in all research that produces results important to workers in more than one discipline, however, dissemination across traditional boundaries is slowed by differences in vocabulary, in research technique and in the way a problem is subtly influenced by the subjects and materials employed by workers in different disciplines. As a result one finds even today that

many psychologists (even those kindly disposed toward psychology) have the impression that little or no progress has been made in the effort to establish the neurophysiological basis of memory. This stems from the fact that psychologists have addressed themselves primarily to the question of how the brain achieves short-term and long-term *storage*.

"My own research has sought to answer more directly the questions posed by psychologists: What kinds of memory process must exist in the brain to allow remembering to take place? The results of this research have cast doubt on at least some of the assumptions about brain mechanisms (explicit and implicit) that are held by both psychologists and physiologists and that in my view have impeded any coming to grips with the problem of process.

"Neurophysiologists had over several decades extensively mapped the brain with electrical recording devices and with weak electric currents to trace nerve pathways. As a result of such experiments on cats, monkeys and even men (performed during neurosurgery) physiologists could speak with some confidence of visual, auditory and somesthetic and motor areas in the cerebral cortex. Although they remained baffled by the 'memory trace,' they still felt they could describe the nerve pathways from a stimulus-input (say in the flash of a light) to a muscular response. The success of these studies often blinded the investigators to the fact that many of these presumed pathways could hardly be reconciled with Lashley's experiments dating back to the 1920's, which showed that rats could remember and could perform complex activities even after major nerve pathways in the brain had been cut and after as much as 90 percent of the primary visual cortex had been surgically removed.

"As a neurosurgeon I had no reason to challenge the prevailing views of physiologists until I met Lashley and was convinced that we knew less than we thought. I soon resolved to continue his general line of investigation, working with monkeys rather than with rats, and in addition to make an effort to follow recordable changes of the electrical activity of the brain as the animals were trained to perform various tasks. Although this work has gone slowly at times (one experiment I shall describe took seven years), my co-workers and I have now gathered neurophysiological data from more than 950 monkeys. The results of these experiments are forcing many revisions in traditional concepts of how the brain works when tasks are learned and later remembered.

"Beyond this I believe there is now available a hypothesis about the nature of the memory trace that satisfies the known physiological requirements and that can be tested by experiment. It is perhaps not surprising that the brain may exploit, among other things, the most sophisticated principle of information storage yet known: the principle of the hologram. In a hologram the information in a scene is recorded on a photographic plate in the form of a complex interference, or diffraction, pattern that appears meaningless. When the pattern is illuminated by coherent light, however, the original image is reconstructed. What makes the hologram unique as a storage device is that every element in the original image is distributed over the entire photographic plate. The hypothesis is attractive because remembering or recollecting literally implies a reconstructive process--the assembly of dismembered mnemic events. In what follows, therefore, I shall give first the evidence for believing that mnemic events are distributed in the brain and then describe experiments that tell us something about the way these mnemic events become re-collected into useful memory processes," (pp. 73-5).

Pribram continues with a lucid description of many interrelated animal experiments which demonstrate the application of advances in technology which have made it possible to

explain the function of the central nervous system in ways which have yielded a great deal of new information. Much of this information has made older simplistic theories obsolete. Our previous ideas about the adaptability of the brain with regard to taking over of functions can now be discarded in preference for the concept of multiple channels and functions of neuropathways. In summarizing his findings and the state of the art, he says:

> "Coding and recoding are thus found to be essential operations in both memory storage and remembering. I have described evidence showing clearly that storage is distributed throughout a sensory system. I have also mentioned some evidence suggesting that the transformations (coding operations) that are performed within the input channels can be described in terms of convolutional integrals. The basic premise involved is that neighboring neural elements spatially superpose the excitatory and inhibitory electrical potentials that arise among neighboring nerve cells. These transformations generate a microstructure of postsynaptic events, which can be regarded as wave fronts that set up interference patterns with other (preexisting or internally generated) wave fronts, producing in their totality something resembling a hologram. Given a mechanism capable of storing this hologram, an image could be evoked at some later time by the appropriate input. In order to be effective as codes, transformations must take place within some stable framework. To an extent this framework can be provided by the stored microstructure itself, by the parallel pathways of the input system, by the specific detector sensitivities of units in the system and by the very redundancy of the external environment. (We have no trouble recognizing automobiles because there are so many of them and they are so much alike.)
>
> "For complex and novel events, however, a more powerful organizer must come into action. Experiments conducted in my laboratory and elsewhere suggest that this organizing mechanism critically involves the association areas of the cerebral cortex. The mechanism does not, however, seem to reside within these areas. Rather, the association areas exercise control on the input system by way of deeper structures in the brainstem. In short, the function of the association areas of the cortex turns out to be that of providing a major part of the organizing process necessary to remembering: the reconstruction of an image from disturbed mnemic events," (pp. 85-6).

IMAGERY TYPES AS A DIFFERENTIAL PERSONALITY CHARACTERISTIC

Most of the early writers hypothesized the possibility of differentiating individuals into groups on the basis of the imagery modality, which seemed to be predominant in their mental processes. This idea is exemplified by Galton's (1883) discovery of scientists who did not use visual imagery as he did. However, he extracted the concept of "imageless thought" as the obvious alternative. Betts (1909) devised a subjective test which he hoped would identify individuals who predominantly used one or another imagery modality. His findings did not support this hypothesis but rather indicated that subjects who reported high or low vividness of imagery did so for all of the sensory modalities.

Jaensch (1930) attempted to differentiate between the *eidetic type* and the *non-eidetic type*. He believed that he found a dichotomous personality factor but was unable to differentiate between heredity and environmental factors as being definitive in causation. He tended to attribute styles of education as being responsible for the development of *eidetics* who had the constitutional potential.

Woodworth (1938) hypothesized the existence of two imagery types which have not seemed to have held up under later investigators. *Visiles* were expected to learn more quickly if the stimuli were presented visually and, conversely,

audiles would learn more efficiently from stimuli presented auditorily.

Gordon (1951) demonstrated an experimental correlation of imagery with performance on a test of reversal of perspective. She differentiated people into those with *controlled imagery* and those with *autonomous imagery*. Those with autonomous imagery differed from the other group in that they were more liable to produce stereotyped image contents which were change-resisting and based on early experience.

On the assumption that occupational choice is in some way related to personality types, or differential aptitudes, Roe (1956) obtained some data concerning imagery modality used by 61 eminent scientists working in several fields. She concluded that:

> "One variable so far little studied in its relation to occupational psychology is that of differences in imagery. . . . Since the controversy over imageless thought in the 1920's, there has been relatively little work of any sort done on imagery. We do know that people vary in the amount and kind of imagery they use, and in the clarity of the images. So far, however, no one has devised any effective means for testing these differences or even for rating them very adequately. About all that we can determine, by questioning, is what kind of imagery the subject employs the most. The commonest kinds are visual and auditory verbal. . . And apparently everyone makes more or less use of imageless thought, of thinking unaccompanied by pictures, sounds, smells, etc., but a 'feeling of relationships,' a sense of something going on, which later may get translated into some sort of imagery. . . .
>
> "What seems to be of importance for occupational psychology is the significant association, in a group of eminent scientists, between field of science and imagery type. . . . The men in each group who deviated in this respect from the majority of that group also tended to be unlike them in interests and in the particular ways in which they worked or the special topics they worked on. There was also some difference in intelligence and personality test results between those whose imagery was predominantly verbal and those with predominantly visual imagery," (pp. 76-7).

V. Lowenfeld (1957) hypothesized the *visual* and *haptic* types as polar positions along a continuum on which all subjects could be located. His preoccupation is with art education as a means of self-expression for which he found a thorough understanding of the individual to be prerequisite for the determination of teaching goals and methodology. Based on observation and experimentation he defined the visual type and the haptic type as follows:

> "The *visual type*, the observer, usually approaches things from their appearance. He feels as a *spectator*. One important factor in visual observation is the ability to see first the whole without an awareness of details, then to analyze this total impression into detailed or partial impressions, and finally to synthesize these parts into a new whole. The visual type first sees the general shape of a tree, then the single leaves, the twigs, the branches, the trunk, and finally everything incorporated in the synthesis of the whole tree. Starting with the general outline, partial impressions thus are integrated into a whole, simultaneous image. This is true not only psychologically, but also for the act of creating. Thus, we will notice that visual types usually begin with the outlines of objects and enrich the form with details as the visual analysis is able to penetrate deeper into the nature of the object.
>
> "This visual penetration deals mainly with two factors: first, with the analysis of the characteristics of shape and structure of the object itself; and second, with the changing effects of these shapes and structures determined by light, shadow, color, atmosphere, and distance. Observing

details, therefore, is not always a sign of visual-mindedness; it can be an indication of good memory as well as of subjective interest in these details. For visual-mindedness it is necessary to see the changes which these details undergo under the various external conditions as mentioned above.

"Visually minded persons have a tendency to transform kinesthetic and tactile experiences into visual experiences. If, for instance, a visual-minded person acquaints himself with an object in complete darkness, he tries to visualize all tactile or kinesthetic experiences. 'How it looks' is the first reaction to any object met in darkness. In other words, he tries to imagine in visual terms what he has perceived through other senses. A visually-minded person who encounters an object in darkness thus tries immediately to visualize the object he has met. From this analysis it becomes evident that the visual approach toward the outside world is an analytic approach of a spectator who finds his problems in the complex observation of the ever-changing appearances of shapes and forms.

"The main intermediary for the *haptic type* of individual is the *body-self*--muscular sensations, kinesthetic experiences, touch impressions, and all experiences which place the self in value relationship to the outside world. In this art, the self is projected as the true actor of the picture whose formal characteristics are the resultant of a synthesis of bodily, emotional, and intellectual apprehension of shape and form. Sizes and spaces are determined by their emotional value in size and importance. The haptic type, therefore, is primarily a *subjective type*. Haptically minded persons do not transform kinesthetic and tactile experiences into visual ones, but are completely content with the tactile or kinesthetic modality itself, as experiments have shown. If a haptically minded person acquaints himself with an object in complete darkness, he would remain satisfied with his tactile or kinesthetic experiences. Since tactile impressions are mostly partial only (this is true for all impressions of objects that cannot be embraced with the hands, where the hands have to move) the haptic individual will arrive at a synthesis of these partial impressions only when he becomes emotionally interested in the object itself. Normally, he will not build up such a synthesis and will remain satisfied with his haptic experience. If he encounters an object in darkness, he will merely withdraw, perhaps, with some feelings of the surface structure of the obstacle or with partial impressions of those parts that he has touched. Since the haptic type uses the self as the true projector of his experiences, his pictorial representations are highly subjective; his proportions are proportions of value," (pp. 265-6).

In a longitudinal study beginning with 17 year old high school students in 1937 and subsequent periodic contacts through 1957, Skolnick (1966) attempted to correlate the imagery products elicited by TAT (Thematic Apperception Test) type stimuli with a number of other personality characteristics. Achievement, affiliation power, and aggression were the original and major global characteristics with many other breakdowns investigated as the work proceeded. In summary her results suggest that it is not possible to make a statement about the relation between TAT and fantasy and behavior that will hold for all motives, ages, and both sexes, although the predominant effect seems to be direct rather than inverse. Results were clearest for achievement and power. Measures of aggression-inhibition correlated directly with measures of overt aggression.

"This study began with the question as to whether the relationship between fantasy and behavior is direct, inverse, or nonexistent. Perhaps the major conclusion suggested by the

results is that it is not possible to make a simple statement about this relationship that will hold true for all motives, ages, and for both sexes.

> "The hypothesis of no relationship may be rejected, although the behavioral correlates of TAT imagery found here are not strong enough to allow for individual prediction with any degree of confidence. We may also reject the hypothesis that imagery is always a substitute for behavior. On the other hand, the relationship between imagery and behavior is not always direct, although this seems to be the predominant direction," (p. 477).

Studying a group of university women at four different levels of experience through training in the field of physical education, Moody (1965) concluded:

> "The. . . findings would not seem to justify the conclusion that significant differences in mental imagery exist among university women who represent relatively high levels of experience, interests, and abilities in motor skills. These same women, however, do seem to be slightly superiod to the more inexperienced subjects in detail recall as indicated by answers about previously observed motor demonstrations," (pp. 62-3).

While her findings tell us nothing about personality typology, they do seem to indicate that a single occupational training group demonstrates some degree of similarity of imagery ability regardless of the degree of training.

The literature does not provide any conclusive evidence that significant personality correlates have thus far been identified with regard to imagery ability. However, most of the investigators are consistent in their belief that such association of characteristics may exist. Their justification is usually based on the lack of adequate techniques and research methodology.

IMAGERY IN CREATIVITY

Although animal experiments have generally not been cited in this paper, it is notable that Linton (1936), a foremost anthropologist of his time, utilized the findings of experimental psychology in developing his concepts of "the background of human mentality." In refuting the popular concept regarding man as the only thinking animal, he cites experimental evidence which indicate not only that lower orders of animals can learn complicated procedures but that they must have the capacity to imagine situations which will result from their own purposeful behavior and thus are creative.

> "It has been held that the superior performance of men in solving new problems is due to their having imagination and reason, qualities which animals lack. Recent experiments make this seem improbable. Imagination is the ability to picture in the mind situations which are not present. Reason is the ability to solve problems without going through a physical process of trial and error. Reason would be impossible without imagination, for in reasoning the situation has to be comprehended and the results of certain actions have to be foreseen. The trials are made and the errors eliminated *in the mind*. If we study human and animal behavior from the same objective standpoint, it seems certain that if we allow these qualities to men we must allow them to animals as well.
>
> "When the young chimpanzees pick up the chips scattered in a room where there are no 'chipomats,' selecting those which are usable in the machines and discarding those which are not, they show imagination. They must have some sort of mental image of the machines and of the use to which the chips can be put. Moreover, from their behavior in the face of situations new to them, we must allow them at least the rudiments of reasoning power. One of the best-known experiments used to determine this consists in putting a

banana in the middle of a pipe, where the ape cannot reach it from either end. After trying direct methods and convincing himself that they are useless, the ape will take a stick and push the banana along the pipe, then go around to the other end and get it. Between the first direct attempts and the use of the stick there will usually be a period of physical quiescence during which the animal is mentally sizing up the situation. During this period mental images of the bananas in non-existent positions must be formed and various methods of getting it into one of these positions pictured, tested against past experience, and discarded, for when the ape begins operations once more he usually seems to have a clear idea of what he is going to do. Moreover, once the problem has been solved, the solution is remembered and the same thing will be done immediately when he is again confronted by the same situation. Apes can even go a step further and fit two sticks together to get a poking tool of the necessary length. In one instance a female chimpanzee confronted by the pipe and banana problem and given a pair of sticks which could be fitted together tried them singly and then gave up and began to play with them. When they fitted together by accident, she showed considerable excitement, took them apart and fitted them once more, then used them to get the banana. Even after getting it, her interest in the sticks continued, and she kept joining and separating them until she had mastered the principle. It is difficult to see how the mental processes underlying such behavior differ from those of a man who makes a discovery and realizes its possible application. Apes will also cooperate in projects for getting food, showing by their actions that they are able to comprehend both the basic situation and what the other apes who are working with them are trying to do.

"In all fields where exact tests can be applied, chimpanzees seem to have the same mental powers as human children three to four years of age. There is a strong presumption, therefore, that the differences in animal and human mentality are purely quantitative. The apes stop at a certain point in the development of the mind, while the human goes on. However, as the ape cannot tell us what is going on inside his head, the best that we can do at present is to render the Scottish verdict of 'not proven.' Even if there are qualitative differences in human and ape thinking, so many of the thought processes appear to be the same that no scientist would doubt that human thinking is a direct outgrowth of animal thinking. Human intelligence, like the brain which produces it, is the result of certain recognizable tendencies in mammalian evolution.

"No one can deny that there are profound quantitative differences in human and ape thinking. The facts are too obvious to require exposition. At the same time, even the qualitative differences must not be overestimated. The complexity of normal human activities as compared with those of animals does not give us a just basis for measurement. In both men and animals most behavior is a matter of habit. Having learned to do a thing, we can thenceforth do it without having to think about it. Our thinking ability is only brought into play when we are confronted by new situations. The civilized man can do more things than the savage because he has had an opportunity to learn to do more things. All the tests which have been applied to the two to date seem to show that their innate mental ability is approximately the same. In the same way, men have better opportunities for learning than apes and this puts them far ahead. The superior mental equipment of men is responsible for the existence of this wealth of things to be learned, but the wealth has been produced by many brains working over many generations. It could not have been created by any one mind. The

son of a civilized man, if he grew up in complete isolation, would be nearer to an ape in his behavior than to his own father," (pp. 66-8).

Most of the writers on the subject have emphasized the dependency of imagery on past experiences. They have also emphasized that the complex stimuli impinging upon individual differences result in new images which are products of the total life experience. Thus, creativity is possible even though the image is made up of components which have existed before. Maltz (1960) popularized these familiar concepts with the new label, *Psycho-Cybernetics*. He recommended the purposeful use of the capacity to imagine and to create synthetic experiences in the form of images as a way of solving most of the problems human beings encounter in everyday living. He cited numerous cases, some commonplace and some extraordinary, in which individuals have utilized imagery to reach goals:

> "Instead of trying hard by conscious effort to do the thing by iron-jawed will power, and all the while worrying and picturing to yourself all the things that are likely to go wrong, you simply relax the strain, stop trying to 'do it' by strain and effort, picture to yourself the target you really want to hit, and 'let' your creative success mechanism take over. Thus, mentally-picturing the desired end result, literally forces you to use 'positive thinking.' You are not relieved thereafter from effort and work, but your efforts are used to carry you forward toward your goal, rather than in futile mental conflict which results when you 'want' and 'try' to do one thing, but picture to yourself something else," (pp. 37-8).

Walkup (1968) is concerned with the present lack of understanding about the relationship of imagery ability to other personality characteristics, and how imagery ability might be a focus of training for creativity, particularly with regard to education for scientific pursuits. He said:

> "The poor way in which creative performance correlates with other characteristics of individuals suggests that we have overlooked at least one important factor in the creative process. This factor may be the widely differing ways in which individuals store information in their minds. Creative persons seem to have stumbled on to powerful methods of programming their knowledge in the form of mentally manipulatable, vivid image analogs. This permits them to explore quickly many combinations of things and to evaluate the worth of such combinations in a way that seems to be at the core of the creative process," (p. 120).

The current literature in the field of education reveals a growing interest in the study of imagery as a factor in almost every field of learning.

Bean (1939) regarding music education, Lowenfeld (1957) art education, Eaton (1959) art appreciation, Fennema (1959) reading, and Radaker (1963) spelling, all explored imagery in their attempts to develop educational techniques.

SUMMARY

In addition to the references to western philosophical and psychological thought, there remains the vast literature stemming from Eastern mysticism and philosophy which might enrich our understanding of the role of imagery in the development of differential cognitive processes as modified by cultural settings. Anthropologists seem quite convinced that modern man differs little in fundamental ways from his forefathers whose artifacts remain for analysis, although knowledge about prehistoric thought processes can only be implied. Our understanding of the role of imagery infers its presence in the minds of prehistoric individuals. Imagery ability is presumed by the finding of graphic representations of their experiences inscribed on the walls of caves.

Perception and imagery seem to have become differentiated by the

acceptance of the concept of the dichotomous nature of cognition which allowed reality to exist in the mind alone. Afterimages presented perplexing problems until they were identified as psychophysiological phenomena rather than products of thought. Because of individual differences of imagery ability among investigators, the concept of imageless thought was not documented until psychology emerged as a science. The idea of the *stimulus error* followed early investigations when it became obvious that certain characteristics of the object were matters of knowledge rather than attributes of the image. The dialogue regarding images versus sensations was long and tedious. Its resolution in favor of differentiation seems to rest upon the hypothesized difference in the nature of the experience rather than merely the differences in degree between perceptions and images. Hallucinatory imagery is currently defined as an abnormal psychic experience which can be induced by chemical toxicity of the central nervous system and severe psychic disturbances whether self-induced or fortuitous. Both innate and cultural factors are now believed to be important in the developmental manifestations of imagery ability. Good experimental evidence is difficult to obtain from the very young child. The performance of behavioral tasks, presumed to require imagery ability, demonstrates that imagery is used as early in life as the integrative process develops and that it follows comparable developmental curves. Attempts to develop a typology of imagery have been numerous. Various systems have been worked out based on such divergent factors as clarity of the image, brilliance, time of occurrence, memory, creativity, symbolism, and sensory modalities. Verbal imagery has been explored at length and seems to be explicitly related to the symbolic value of the verbiage in evoking associations which are manifested by images in one of the sensory modalities. Memory is essential to the meaningful use of imagery since images are created out of variously modified and recallable past experiences. A few attempts have been made to correlate personality types with degrees and modes of imagery ability. Thus far some occupational differences have been inferred on the basis of preferred sensory modalities for learning, i.e. visual or verbal, visual or haptic. Nothing conclusive has been found to tie specific imagery abilities with incisive personality configurations. Because of the importance of creativity as a cultural value in western civilization, imagery ability as it relates to creativity has been scrutinized. Considerable experimental and clinical evidence indicates a significant relationship between imagery ability and potential to benefit from differential educational experiences in creative fields.

Thus, the work of the study of imagery is well along toward the completion of the foundation on which to build a psychology of imagery. As in every other field of scientific investigation, the work completed has yielded the answers to the initial hypotheses and has raised a multitude of new questions. Without waiting for further research findings, practitioners can apply the present knowledge to selection, training, and education. The goals which might be achieved are those of greater personal satisfaction and social contribution.

Part II

Imagery and Blindness

PURPOSE AND SCOPE

No effort has been made to include under this topic all of the theoretical and experimental material regarding imagery or blindness. Further, only a cursory review of the relevant literature regarding the function of imagery in persons who are blind is claimed. Most of what has been said elsewhere about imagery as an important cognitive function in man is equally relevant to the special case of the man who is blind. Reference is made to twentieth century authors whose observations seem more germane to our present attempt to understand the function of imagery as it relates to personality development, education, and rehabilitation of the blind.

The blind are divided dichotomously into functional subgroupings identified as the congenitally blind and the adventitiously blind. For the purposes of this discussion, the congenitally blind are those individuals who have been blind from birth and those who lost their sight so early in life as to have no meaningful residual visual memory nor a functional visual imagery ability. The adventitiously blind conversely are those individuals who lost their sight after the visual modality had become an integrated part of their psychological processes and remains available to them as a meaningful aspect of cognition. Very little is known about the emotional residual from early visual experience of the congenitally blind. Although that subject is obviously one which should be investigated thoroughly, it is not given consideration here. The partially-sighted individual, who is able to perceive structure and form in the physical world, regardless of the time of onset or duration of blindness, is not categorized as a blind person for the purposes of this discussion. The meager evidence regarding their quantitative performance indicates that their gross visual imagery performance is comparable to that of the fully-sighted population. In view of the individual differences in imagery ability thought to be characteristic of a normal population, both the quantitative and qualitative aspects of all modalities of imagery would seem to be another area warranting more attention of investigators of imagery in the future.

Hayes (1949) in a general discussion of "Imagination" emphasized the importance of developing imagery ability in all spheres.

> "Ordinarily when one speaks of imagining one thinks only of visual imagery, but there are many other kinds. Let us try a few other experiments. Can you call to mind the sound of an automobile horn, the bark of a big dog, the sound of your own name when called by one of your friends? If you can call up these images we say that you have auditory or sound imagination. Can you recall the smell of coffee, the odor of freshly cut grass, of fresh paint? Can you imagine the taste of sugar or salt? Can you recall the feeling of smooth glass, of sandpaper, silk, or wool? Can you without moving your hands imagine what it would be like to shake hands with someone, to climb stairs or a ladder, to open a door, to comb your hair? Such images of touch and movement are very common, and often very important in remembering our actions, and they may be very misleading if the things we plan to do are different from the images. Those of you who play the piano are doubtless familiar with the phrase 'getting a piece into our fingers,' that is, practicing it so many times that when you begin to play it you simply let your fingers go and *they* seem to do the rest. You are then guiding your performance by kinaesthetic or motor images. We may have still other images classed as 'thermal' or 'pain' images. You can easily recall the feeling of cold water on the face, or hot potatoes in your hand

or in your mouth. You can imagine the prick of a pin, a burn, a bump or a scratch. Any kind of sensation that we can get from the world about us may return in our imagination as an image," (pp. 189-90).

Utilizing a more restricted set of concepts regarding imagery, Levine and Blackburn (1946) state, "Without sight the individual is thrown upon three basic perceptual faculties to aid him in getting around: 1. Visualization of spatial relationships, 2. Hearing, and 3. Kinaesthesis," (p. 141). Nevertheless, the adult who deliberately attempts to vitalize the experiences of life tends to develop an awareness of all sensory input and to utilize the memories of his experiences in combination to enrich new experiences and to solve new problems. This would seem to be true even if we accept Victor Lowenfeld's (1957, pp. 262-4) typology of the visual and haptic which form poles of a continuum with approximately 50 percent of the population being predominantly visually oriented and only 25 percent predominantly haptically oriented.

EARLY SENSORY DEPRIVATION

In spite of popular ideas to the contrary, persons who are blind do not necessarily suffer from the impairment of hearing or other sensory modalities. While it is true that many congenitally-blind children are born with other disabilities resulting from genetic or prenatal influences which were also the cause of blindness, the multihandicapped blind person is not our special concern here. The adventitiously blind occasionally acquire additional disabilities which complicate the adjustment process. For the multihandicapped blind child or adult the acquisition of adaptive behavior patterns is more complicated and time consuming requiring additional specialized treatment and training.

The focus of this discussion is on the effects of blindness as it complicates the process in the development of spatial relationship concepts. From what we know about the development of the sighted child it is evident that early responses to visual stimuli are reacted to more or less innately. However, meaningful behavior is soon noted as visually-perceived aspects of the environment become familiar and take on positive or negative values. As binocular coordination develops, depth perception is feasible and spatial relationships take on meaning. The world is there to be seen and to be experienced by the normally-developing child and as exploration becomes possible so does the development of elementary conceptualizations regarding spatial relations. That this is a normal process does not imply that it is a simple one. Most of us have no subjective recollection of these early experiences but who has not pondered the problems of solar space not to mention the concept of infinity. These larger problems would seem merely an extension of man's struggle to locate himself in the universe and to learn to move in it.

Most of what we feel we know and report here comes from clinical observations and subjective reports. Although the congenitally blind provide us with an experimental population, it is not possible to manipulate environmental factors in an adverse manner in order to verify hypothesized effects of positive treatment. The prolonged maturation period of the human subject is an additional complicating factor interfering with controlled research. Most of the studies reported in the literature refer to experiments involving temporary sensory deprivation of adults and more drastic procedures, often irreversible, with the use of laboratory animals. Nevertheless, there has been an expanding interest and experimental field of study stemming from brainwashing procedures and outer space exploration.

Bruner (1961) attempts to summarize some of the relevant experimental findings in the following remarks:

"One word about the effects of early deprivation. Little is served by fighting over the stale battlegrounds of yesterday's theorizing. There *has* been a greatly increased interest in the manner in which cognitive functioning and perception

are shaped by the instrumental role they play in the enterprises of an organism. There have in the past been pleas of protest that this instrumental bedding of perception played no role in shaping its character or laws, that only responses are altered by virtue of instrumental requirements. Such a view comes from the ancient and honorable assumption that all there is to perceiving is the pattern of intensities, durations, and sensory qualities. It is obvious that this inference is also a formidable factor in perceiving, else there would not be such a huge difference in recognizing the random word YRULJZOC and the fourth-order word VERNALIT, or frequent and infrequent words would be recognized with equal ease. Inference depends upon the establishment of rules and models, and it also depends upon the development of strategies for arriving at roles and models. I have proposed in this paper that early experience with a normally rich perceptual environment is needed for such learning--that deprivation prevents it.

"Let us, finally, explore the implication of work on early deprivation for our understanding of the effects of sensory deprivation on the functioning adult organism. It would seem, first of all, that not only are there critical problems of the development of adequate models of the environment and adequate coping strategies, but that there are also maintenance problems of an order of delicacy that were not even imagined before the pioneering experiments of Hebb and his associates at McGill. The work reported by the contributors to the present volume emphasizes not only the need for variable sensory stimulation as a condition for maintaining a functioning organism, but also the need for continuing social contact and stimulation. We have yet to study the relative effects of each of these sources of maintenance, but it would appear as if they may serve a vicarious function for each other: Where social contact is maintained, as in the efforts at Mt. Sinai in New York to keep up the family contacts of children in respirators, the cognitively debilitating effects of reduced stimulation are notably reduced. It would not be unreasonable to guess that social contact provides a symbolic analogue or vicar for sensory intake.

"What is this maintenance problem? I would like to suggest that it perhaps relates to a kind of continuing feedback-evaluation process by which organisms guide their correction strategies in perceiving, cognizing, and manipulating their environments. Let me suggest that the unhampered operation of this evaluation process is critical in the continuing adaptation of the organism, both in the development of adequate cognitive functioning, as I have suggested, and also in moment-to-moment functioning, . . ." (pp. 204-5).

EARLY VISUAL DEPRIVATION

The result of early visual deprivation can certainly have all pervasive negative results where adverse environmental factors are present. The results can also be complicated when abnormal intellectual and emotional development occurs simultaneously regardless of the causation. Without compensatory experiences, usually provided first by the mother and later by other significant persons in the immediate environment, the congenitally-blind child will be more concerned with subjective experiences than he is with the stimuli impringing upon him from an ambiguous outside source. It must be remembered that even auditory and tactile sensations are known to the neonate as subjective phenomena until he establishes an awareness of the boundary between self and outside of self which is provided by his skin. Binaural audition, for example, is not a meaningful attribute to the infant. It can only have significance as a prober of depth as he learns through experience to differentiate the qualitative as well as the quantitative aspects of sounds at varying

distances through an infinite number and variety of experiences. While sound comes to him from many sources, only his bed and clothing are there to be felt and the manipulation of his body brought to him periodically by his mother. Without encouragement of a particular sort the infant will not be stimulated to explore his crib or later the room or still later the normally expanding environment of the child. For the blind child associating his body parts into a meaningful whole would seem to be equally important as it is with the sighted child but even here tactile exploration may need to be encouraged since the flexing of his body parts will not provide the usual interest aroused through visual stimulation. The contact with the mother figure will be even more reassuring and important to learning during the early stages of life in the development of the child's awareness of the outside world. The entire process of feeding and learning to feed himself becomes of major importance in that spatial relations are involved and the manipulation of external objects through space becomes purposeful as a means of satisfying a physiological need. While some of the other developmental processes follow along much the same courses as are typical for normal children, the acquisition of and utilization of mobility skill again requires special attention. For the reader who is interested in a detailed interpretation of the special aspects of attending to the developmental phases of the blind child, see Cutsforth, T. D. (1933, b) and Lowenfeld, B. (1956).

Sandler (1963) studied a series of cases using the classical analytical developmental concepts. Although she acknowledged that individual congenitally-blind children seemed to have experiences through which developmental achievements were accelerated, she apparently believes that trace deviations will persist in even those cases. Some of her "implications and conclusions" are as follows:

> "By the end of the first year we can see substantial individual differences in blind babies. They will have had their development influenced by limitations in their endowment (and by any superimposed brain damage), and also to a considerable degree by the maternal care they have received. But however excellent the mother's handling of her child may have been, the regressive pull toward self-centeredness and the basic retardation in ego development will always be present. On the side of drive development there will be some degree of fixation to passive instinctual aims, and on the side of the ego there will be a relative lack of neutralized energy (necessary to sustain interest in the outside world). We will generally observe a much lesser drive to mastery and to progressive adaptation than we have learned to expect in normal sighted children. It is inevitable that this must have a profound effect on later stages of development, but a discussion of later development lies outside the scope of this paper.
>
> "The commonly observed retreat into passivity--or more appropriately, the retreat from the external world--appears to differ in an important respect from the neurotic withdrawal into fantasy which, on the surface, it resembles. In the neurotic withdrawal overt activity is replaced by a proliferation of the child's fantasy life in which the child continues his forbidden activities in secret, so to speak. This fantasy life is rich in ideational content, and the objects of the child retain their full cathexis, although they are now manipulated in fantasy. It seems that in most of our blind children, on the contrary, there is a turning rather to the evocation of sensory experiences which are rich in erotic or aggressive sensations, but poor in ideational content. The mental life of these blind children will thus be much more directly related to the sensations arising from the instinctual zones, and will be connected with need satisfaction of a primitive type.
>
> "It has often been stressed that the blind baby, who ought to receive an extra amount of stimulation to make up for his lack of vision, usually receives

less than he otherwise might, because of his mother's reaction to his deformity and the difficulty she experiences in making contact with him. She may lack much of the intense pride a mother would have in a normal baby; but, in addition, whatever positive response she may have to her baby's progress, it will be generally difficult for her to communicate it successfully to him. He will not see her facial expression, her look of pleasurable expectancy, her smile or encouraging glance, and this lack of feedback will seriously affect the blind baby's achievements and pleasure in outward-directed activities," (pp. 355-57).

Since it is obvious that the infant does not learn to interact with the physical environment in a social vacuum, Burlingham (1961) describes the importance of the mother's attitude in her relationship with her blind child as follows:

"Based on her work with the mothers of blind infants and children, Mrs. E. M. Mason has described repeatedly the difficulties and obstacles which mother and child meet in making their first contact. In contrast to the pride and pleasure which a mother feels in her normal baby, Mrs. Mason has shown how the mothers of the blind are affected by the first discovery of the child's visual defect whenever the discovery is made by them and confirmed medically. She has described their feelings of injury, of hurt pride, of guilt, and of the depression which make them withdraw emotionally from the child and sometimes unconsciously or rationally wish for his death. It is only natural that the baby in this most vulnerable period reacts on his side to the mother's withdrawal and in turn answers with passivity and withdrawal far beyond the degree caused by the visual defect itself. According to our observations, therefore, blind babies who need an excess of stimulation to counteract the lack of visual stimuli receive less than the normal child. This has far-reaching effects on the further development of their emotional life. It also has side effects on the development of all the ego functions of the child, which the present paper is trying to describe," (pp. 121-2).

The problem of generalizing about the development of the congenitally blind child is complicated by hereditary individual differences and additional birth defects or injuries. Norris, Spalding and Brodie, in the longitudinal study of a large number of blind children made a significant contribution toward the abolition of the then commonly held belief that additional neurological disabilities usually accounted for deviant behavior among children blind from retrolental fibroplasia. So far as their findings were concerned, there is no evidence that retrolental fibroplasia is associated with a specific or a generalized brain defect. They further state that when there are no specific neurological findings but that functional retardation is present, the retardation must be presumed to be directly related to complex social and environmental factors.

The difficulties in achieving the various developmental states are forcefully described by Fraiberg and Freedman (1964) in their study of normal and deviant developmental patterns when they state:

"We contrast this with the picture of the persistently mouthcentered deviant blind child. The invariable picture of these children showed them lying on a bed or sitting on the floor absently mouthing or sucking or tonguing or chewing a clothespin, a rubber toy, or a metal ashtray. In the case of the deviant child, perception could not free itself from the erotogenic overload of the mouth and remained in a kind of morbid alliance with the drives. There was no interest in objects other than those that were connected with need satisfaction or self-stimulation (as we saw in Toni, too, during the first year).

> "We do not know why the deviant children failed to develop hand autonomy. As already indicated, however, we feel that this failure is crucial and is one of the factors that maintains the personality on the level of non-differentiation. What we can see through the study of Toni is that the adaptive use of the hand as a primary organ of perception is an extraordinary feat which even under favorable circumstances evolved very slowly in this one blind child. We are accustomed to take this adaptive achievement for granted in the case of the blind child. The study of deviant blind children teaches us that the route to hand autonomy for the sightless child is so complex that it may never be found at all," (p. 168).

The result of neglect of the special needs of the blind child with regard to his introduction to the physical world can be catastrophic. It is probably unsafe to speculate as to how early and by what means the individual child normally acquires and manifests a meaningful awareness of himself in space. However, the blind child's deficiencies become self-evident when normal developmental tasks are attempted. He may appear totally unaware of his surroundings other than those persons in it whom he has learned to depend upon for the gratification of his physical and emotional appetites. As he progresses in other spheres, specifically intellectual and verbal, the divergence between those abilities and the ability to cope with the physical environment are evident. That some of such children are at all mobile in familiar surroundings is probably due to rote learning as response to kinesthetic stimulus patterns acquired through time and an unnecessarily large number of trial and error experiences. To venture beyond the familiar environment without a sighted guide means to encounter the unknown and virtually the unknowable. Should the deficit in the realm of spatial concepts be allowed to persist through adolescence to adult life, the individual will have, at best, only a fragmentary awareness of the environment in which he lives.

While he will be acutely aware of his deficiencies if he attempts to function in space as do his sighted contemporaries, the casual observer may assign his difficulties to a lack of experience or a degree of awkwardness attributable to his inability to see. A further misleading factor is the usual verbal facility acquired by the congenitally blind regarding spatial concepts. They have learned to talk about the physical aspects of the world from hearing others do so and have learned that such verbal behavior is a social necessity even though they may not have any comprehension of that which they are discussing.

For some a limited system of spatial concepts may have developed which enables them to deal, more or less adequately, with the physical environment they are able to contact tactually from a fixed reference point. Others are able to associate two or more such sets of spatial relationships in a side by side configuration but have no capacity to unite the units into a continuum. A few have reported using kinesthetic modalities, such as walking a few steps further or turning to the right or left, as their means of connecting one segment of space with the next. Others are inclined to operate along a temporal continuum during which the various physical features of the environment are encountered, anticipated, or known to occur. Again these individuals are unable to grasp the environmental parts as segments of a meaningful larger unit. Thus the interior of a "familiar" building may be experienced as a series of doorways with windows and stairways separated by stretches of walls, with or without identified textural characteristics. The individual may move from a verbally identified starting point, such as "the front door," to one or more points within the building which he has learned to find following a fixed sequence of temporal intervals, tactual cues, and/or kinesthetic sensations. Upon close examination such persons are found to be unable to conceptualize the architectural and functional relationships of the structure regardless of the amount of explanation provided.

It may indeed be almost impossible for the uninitiated reader to appreciate the magnitude of the handicap such an individual experiences in attempting to cope with a new situation. Perhaps the most illustrative examples are the individuals who cannot conceive of a hallway with rooms on either side although they are able to reach a desired objective on one or the other side of the hall by means of learned travel patterns from point to point; or those individuals who have no conception of a square city block and thus cannot reach a designated point described to them as being "around the block." While everyone has had the experience of being lost, it is usually the result of inattention to the route of travel or the existence of some unanticipated structural deviation. When the sighted or blind individual with a normal degree of spatial relationships finds himself lost, it is usual to inquire for further verbal instructions or to proceed cautiously toward the acquisition of necessary visual, tactual, or auditory cues to reestablish orientation in the environment. For the individual who does not have the capacity to imagine the possible variations in architectural and geographic configurations, such reorientation cues are of no avail. The alternatives are to wander aimlessly, to obtain assistance to reach each objective, or to seek sufficient instruction to enable him to learn the particular travel route so that it may be retraced with some degree of assurance.

IMAGERY OF THE CONGENITALLY BLIND

As has been lucidly described elsewhere, the congenitally blind experience nothing which is comparable with the visual imagery of the sighted person. Without having had vision, without the development of the complex phenomenon of visual perception, and without visual memory, the psychological mechanisms necessary for the processing of visual imagery cannot exist.

Auditory imagery, in its various forms, would seem to remain intact. While it will not call forth the rich visual images often experienced by the sighted through a process of transposition, it may serve the blind to a greater extent since the auditory perceptions may have been given more attention and are therefore more available to recall and interpretation than is usually true with the sighted person. However, it is important to remember that individual differences prevail and not all of the blind will demonstrate any unusual application of auditory imagery in the activities of daily living or in specialized activities such as the performance of music. Perhaps the most important aspects of auditory imagery as used by the blind are the limitations on information gathering provided by the original auditory perceptions. While probably not so important in the special case of verbal imagery, much of what is heard by the blind fits into the individual's own subjective context, but not necessarily into the realities of a dynamic spatial context lying beyond his reach and verification through haptic modalities.

The senses of taste and smell should also provide comparable important modalities having both practical and aesthetic values. Here again the sighted person is most likely to exaggerate the richness of the perception and the imagery in these modalities because of the tendency to associate them with meaningful visual experiences. The odor of perfume without the vision of the wearer or the taste of food without the accompanying image of an attractive meal would seem to be somewhat less exciting.

Haptic experiences, while phenomenological wholes, differ for the congenitally blind as do other imagery forms in that they do not stimulate the process of transposition to the visual modality. When the blind individual says that he "sees" an object he merely means that he is perceiving it in the best way he can. Neither he nor the sighted observer will ever be able to communicate the differences in their perception or in their images of the same object.

To enlarge upon the problem of forming images, Révész (1950) derived some additional operational principles when he said in part,

"In discussing the spatial consciousness of those born blind

we have to start from so-called empty space. The impression of space in the resting condition in those blind from birth does not differ from that in seeing persons and in such as lose their sight at a later age, except for the fact that the intrinsic quality of that space does not show any visual form. . . . Usually the space which surrounds one's own body, and is therefore intimately connected with the person, is termed 'near space.' It represents a system of correlates in the center of which the ego, the psychophysiological person, is situated. . . . The empty static space develops into the 'space of action,' which gains in content and importance especially through the feeling of freedom of motion. In spite of the fact that it extends beyond the near-space, the space of action is not yet experienced as distant space. . . .It is only the occurrence of an actually non-spatial, but spatially localized sensory impression (e.g., an acoustic stimulus originating at a greater distance from the blind observer) that converts the near-space into a distant one. The blind person feels his vital sphere suddenly extend beyond the boundaries of the near-space, and space becomes determined in respect of direction and relation to the external world. By means of localization the kinaesthetic space becomes endowed with content and the blind observer is on firm ground."

". . . It is only when the blind subject comes into direct contact with the world of objects and apprehends objects by tactile examination, that the concrete haptic space becomes manifest. This space is very limited, however. As for the possibility of perception, it includes merely that part of the space which is open to tactile examination, and the perception it encloses does not extend beyond the haptic perceptions of objects which are given at a particular moment or which have only just been formed. The blind man cannot be content with such a limitation; and he is therefore constantly aiming at extending his world of objects in one way or another. That is achieved partly through abstract additions to the perceived image, partly through making use of cognitive data and taking them into consideration."

"The concepts of objects situated side by side or one behind another have a quite different phenomenal content and a different significance in the space of those born blind from the visual sphere. Objects perceived by touch are in the first instance brought into relation to the subject and not to each other. Objects situated side by side or one behind the other form an image group which is poorly, if at all, integrated; they carry on their individual existences and play hardly any part in the constructive build-up of the concrete space. The difficulty of uniting the haptically perceived objects into a homogeneous spatial structure is further increased by the lack of a background. The part played by the formative function of the background and the importance of a plane of projection to give the objects contour and sharpness are never more marked than in comparing visual and haptic group-formation. . . ."

"Things are quite different in the space of the blind, to which the objects give neither life nor tension nor motion. It is the *statics of objects* that governs the haptic space. The objects do not alter their phenomenal appearance. The tactile impression always remains the same, in whatever way one may touch the objects. There is nothing analogous in the field of Haptics to the position of the observer, the change of light and shade, and the change of distance in the visual sphere. The lack in vividness and diversity becomes especially marked through the fact that impressions of movement, which make the spatial image emerge from its static condition, do not occur in the purely haptic world. Acoustic impressions and movements do not

enable the blind person to experience that perceptive effect of movement, which by means of the movements of objects of the ambient world (a man, an animal, vehicles, clouds) fills the visual image of space with life and endows the whole with a character incomparable to that of any other sensory space," (pp. 158-61).

From the above descriptions of modes of perception and imagery the congenitally blind would seem to suffer an extreme form of deprivation if it were not for the obvious tendency of man to respond positively to favorable environmental factors and to fill his affective and cognitive life with positive and meaningful experiences. Granted that the subjective apprehension of spatiality is different for the sighted from that of the blind, there would seem to be no objective reason to hypothesize an inferior qualitative total life experience for the congenitally blind. Perhaps the greatest deprivation is living side by side in a world in which he is one of a minority among those who share a perceptual modality, which while limited to the visible spectrum, is highly developed, highly integrated, and acutely sensitive to the environment. The reduction of the disadvantage that the congenitally blind have regarding spatial relations would seem to rest on a better understanding of the psychological problems and the development of remedial training or treatment methodologies. The goals of such efforts cannot be to equip the blind person with the lacking visual perceptual mechanisms but rather to assist him in the development of his potentialities to cope with and enjoy the problems he will encounter in learning to live in the world designed for sighted people.

REMEDIAL TREATMENT FOR THE CONGENITALLY BLIND CHILD

It is not our purpose to report or enlarge upon the work of child development and educational specialists who have written extensively on their understanding of these problems and their methodological findings and recommendations. May it suffice to say that the concept of *readiness* should be a pervasive principle in determining when and what experiences should be offered to the child. Opportunities missed in the developmental process are seldom if ever regained. Not only are there physiological optimal developmental phases for the introduction of specific activities but there are equally important and fleeting motivational periods which must be utilized when they occur. The parent and the teacher must be knowledgeable enough to anticipate these opportunities to move in with the appropriate challenge, support, and whatever apparatus is necessary to lead the child to formulate the best possible conceptual framework of which he is capable with regard to spatial relationships. Without some workable concept of the environment in which he lives, imagery ability of whatever sort will not develop into a meaningful approach to his world.

It has long been a common practice to utilize scaled down models and maps to bring physical representations of the environment to the blind through the haptic channels. The adventitiously blind accept this means of apprehending spatial relations with minimal difficulty since it is comparable to visual representations with which they have had experience. The practice has been extended freely to work with the congenitally blind and has not always been successful in fostering the desired development of useful conceptualizations. However, Gilson, Wurzburger, and Johnson (1965) report the careful use of raised maps in teaching orientation and mobility to both congenitally and adventitiously blind children. They emphasize that the study of maps and simplified three dimensional representations of geographical patterns can be very useful in the development of the concepts of spatial relations when such study is accompanied by work in the field with a student. The map then becomes understood as merely a schematic representation of the reality which has much more detail and an entirely different experiential connotation. Such thoughtful and careful work, while validated only by the performance of trainees may eventually lead to the disclosure of the basic psychological processes by means of

which the congenitally blind construct and retain useful imagery relating to the orientation which makes purposeful and efficient mobility feasible.

LATER SENSORY DEPRIVATION AS SEEN IN THE CASE OF THE ADVENTITIOUSLY BLIND

Not to diminish the magnitude of the problem confronted by the adventitiously-blinded person as a child, adolescent, or adult, nor to belittle the progress made by rehabilitation workers, it remains evident that there is much to be learned about the human organism as it functions normally before we can feel confident with our present remedial activity. Discussing the state of the art, Cobb, in 1958, clearly indicated the new directions to be traversed and the depth of the unknown when he wrote,

> "The last ten years have brought about a complete revision in our understanding of the central nervous system. One no longer thinks in terms of stimulus and response through an integrating switchboard mechanism. The reflexology of Sherrington and Pavlov has been supplanted by a new knowledge of reverberating circuits, feedback systems, communication theory, and the central modulation of sensory perception. A new picture of the activity of the brain emerges: a picture of a prosencephalon alerted to receive selected stimulation by mechanisms in diencephalon and mesencephalon, which in turn can influence peripheral sensory input. Moreover, it is a picture of each of these levels acting on the others by signals from internuncial circuits. The whole concept gives an idea of the continuity and rhythm of cerebral processes. It explains the function of many neurones and short tracts that, until recently, had anatomical names but no particular meaning."
>
> "In all of this, perception plays a great part. But who can define perception? Can we simply call it a word for how things look to us, or why they look differently to others? This is vague and unsatisfactory, and suggests how much we need a critical study," (p. xvii).

Unfortunately, most of the sophisticated studies of sensory deprivation in adults involve attempts to deprive the subjects of total sensory input so far as it is methodologically possible. Thus these studies do not provide much information regarding the consequences of blindness alone. The research done with blind and blindfolded subjects usually is designed to measure remaining capacities to perform specific tasks and has little to do with the development of our understanding of the total effects of blindness on the physiological, emotional, and intellectual processes. Since we have not known enough about the effects on the integrative process, we have had to be satisfied with descriptions of behavior, psychometrics, psychophysical measurements, somatopsychological correlates, and related theoretical constructs. Until very recently experimental procedures have shed little light on the subject but more recently have begun to validate old beliefs, new hypotheses and tests within the limitations of the methods appropriate to the behavioral sciences. It must be admitted that our current most useful insights regarding the behavioral aspects of blindness emerge from more sophisticated clinical observations. This is a twentieth century development and is far superior to the philosophical musings and subjective reports of earlier times.

From his observation of World War II veterans and subsequently civilian casualties in training at organized rehabilitation facilities for adult blind persons, Carroll (1961) made a major contribution to the field by insisting that blindness per se is a *multiple handicap*. He breaks the consequences of blindness down into twenty functional losses:

1. Loss of Physical Integrity,

2. Loss of Confidence in the Remaining Senses,

3. Loss of Reality Contact with Environment,

4. Loss of Visual Background,
5. Loss of Light Security,
6. Loss of Mobility,
7. Loss of Techniques of Daily Living,
8. Loss of Ease of Written Communication,
9. Loss of Ease of Spoken Communication,
10. Loss of Informational Progress,
11. Loss of the Visual Perception of the Pleasurable,
12. Loss of the Visual Perception of the Beautiful,
13. Loss of Recreation,
14. Loss of Career, Vocational Goal, Job Opportunity,
15. Loss of Financial Security,
16. Loss of Personal Independence,
17. Loss of Social Adequacy,
18. Loss of Obscurity,
19. Loss of Self-esteem,
20. Loss of Total Personality Organization.

From the foregoing twenty losses, one would conclude that Carroll is describing a thoroughly regressed individual. Experience indicates that regression occurs in different degrees and in different spheres of activity. The manifestations may be affected by genetic and experiential factors which will in complex ways predispose the individual to degrees of regression in response to types and degrees of deprivation. The cessation of visual stimuli accompanying the awareness of permanent blindness seems to bring about a psychological state which is in many ways comparable to temporary deprivation of all external stimuli. Most people are predominantly visually oriented and there is no automatic and immediate substitution of alternative perceptual channels to re-establish meaningful contact with the environment. The usual preoccupation with internal stimuli is analogous to early developmental stages and thus is a regressive process in an adult.

Using the medical model Cholden (1958) formulated a description of the initial reaction to blindness and hypothesized some theoretical explanations regarding the usefulness of the initially overwhelming phase.

> "If an adult suffers loss of sight with any degree of suddenness, he will usually react with a state of psychological immobility that can best be described as a state of shock. During this period, which may last from a few days to a few weeks, he finds himself unable to think or feel. (One patient aptly described this time in terms of feeling 'frozen.' He felt nothing.) It would seem that his new task is so formidable that he must approach it by retrenching his energies for a time. He reacts to the feeling of imminent chaos and disintegration by an emergency construction of his ego. I have often heard patients describe their lack of feeling pain or anything else the week after they became blind. It is understandable for the patient to isolate his feelings and to reflexly withdraw his interest in the environment and the awareness of emotions relating to his condition, in order to protect himself from the severe pain he would otherwise feel. We can then think of this shock stage as a period of protective emotional anaesthesia which is available to the human organism under such stress.
>
> "The degree of damage to the ego and the capacity to recover from the initial shock reaction will depend on the degree of ego-strength and maturity attained at the time of the disability. The way the individual has learned to cope with his major life problems and emergencies antedating his blindness will largely determine his ego-recovery capacity as far as blindness is concerned, assuming, of course, that the external obstacles are not too great."

"A tentative hypothesis which has emerged from rehabilitation work with the blind might be stated as follows: The longer the shock state, and/or the greater the number of shock episodes, the more difficult is the person's rehabilitation to blindness.

"This principle has important implications in the treatment of the newly blinded person. For a while, no readjustment effort is effective during this withdrawn state; the shock state can be re-induced by raising and then dashing hopes for the return of vision during the readjustment process. I know of no investigation which assesses the effect of therapeutic efforts to abort or change the course of this state of emotional withdrawal. In fact, it would seem unwise to do so, for the patient seems to need this time to marshal his forces and reorganize his inner strengths to meet the new challenges before him. Attempts to prevent the patient from entering the next stage, that of depression, often leaves him with a prolonged shock stage," (pp. 73-5).

In the second phase of the reaction to blindness Cholden discusses the *reactive depression* during which further regressive phenomena occur on an emotional level.

"As the newly blinded patient begins to experience emotions again, what he feels, and the way he reacts, seems similar in all respects to what is often called a 'reactive depression.' We see the usual self-recriminations, feelings of hopelessness, self-pity, lack of confidence in meeting problems, suicidal thoughts and psychomotor retardation. The patient is then reacting emotionally to his loss. He recognizes the loss of his vision and begins a period of mourning for his dead eyes, . . ." (p. 75).

He emphasizes that the depression is a necessary and important aspect of the total adjustment process and that it should not be aborted by the offering of unfounded hope for the return of sight. Thus persons who have not completed their mourning period will not progress toward the acceptance of their new status nor will they be able to accept rehabilitation therapy. Should such an interruption of mourning occur, fixation at a regressed level is probable and dependency inevitable. It is not uncommon to find blind persons twenty-five years later still awaiting the return of sight, still resisting rehabilitation, and still highly dependent on interested persons to gratify their basic physiological and emotional needs.

As described by H. Azima, R. Vispo, and F. J. Azima (1961) the superabundance of human attention can exacerbate the process of regression by adding the availability of dependence on a therapist to the state of deprivation. In their clinical studies, neurotic patients who were artificially deprived of normal stimulation but were given an optimal amount of emotional support, manifested marked regression and some expected fixations. Such evidence would seem to parallel and confirm the usual clinical observations supporting Cholden in his hypothesis concerning the "death of the sighted person" as a necessary phase of adjustment to the state of blindness during which phase normal reaction to the outside world has not yet been reestablished.

IMAGINATION AS A FACTOR IN THE ADJUSTMENT TO BLINDNESS

It would seem evident that the individual who reaches the state of intellectual and emotional acceptance of blindness would necessarily draw upon his imaginative powers during the process of contemplating his future. If all of his past experiences, cultural traditions, personal contacts, and objective knowledge about blindness are negative, his formulations regarding his own future will be equally dismal. In the event that he has had more or less positive emotional responses, personal experiences, and factual knowledge regarding blindness, he might well be able to imagine an acceptable way of life for himself as a blind person. Other factors such as self-confidence, environmental permissiveness, and personal aspirations, may well moderate

his evaluation of the future. At this level of subjective activity, the amount and kind of imaginative thought which was characteristic of his premorbid life would certainly be a determining factor regarding his ability to deal with his new situation. Thus positive imaginative constructs can be hypothesized as good motivational factors and negative constructs as regressive, self-defeating, negative motivations. The transition from imagining one's future, possibly even with the use of imageless thought to the process of imagining one's self in real or hypothetical situations is undoubtedly difficult to differentiate. Predisposing factors, both phobic and creative, will determine the rate of transition and the resulting behavior.

VISUAL IMAGERY IN THE REHABILITATION OF THE ADVENTITIOUSLY BLIND

As has been demonstrated clinically and experimentally, the ability to use visual images constructively is a highly variable individual difference. Although it seems to be related to general intelligence and to genetic and cultural factors, it has not yet been scientifically demonstrated that the level of performance can be measurably changed by training following the onset of blindness. Carroll (1961) in his program for the restoration of the twenty losses resulting from blindness, takes the position that the adventitiously-blind person can be trained to utilize visual imagery to solve many of the problems encountered in the activities of daily living. This position has long been an operational hypothesis utilized by rehabilitation workers with varying degrees of success. However, Carroll goes further than many of his predecessors by emphasizing the importance of the ability to translate haptic perceptions and visual memories into working models through the introduction of specific training activities.

To explore the complexities of the problem encountered by the adventitiously blind in attempting to deal with the physical world as if it existed in the mind's eye even when the objects of interest are accessible to other sensory modalities, Révész (1950) says,

"Let us now consider the problem of active visualization, i.e., the active translation of haptic impression into the visual field. In connection with the purposive attitude, which activates visualization, the visual elements emerge in their specific mode, so that it becomes possible to separate what was united in the total impression.

"The answer to the question what it is that actually becomes visualized as a result of the purposive attitude, directed towards the recognition of a tactile object, is that it is a schematic form and not at all the total visual image. What is aimed at is not a visualized image of the haptically perceived object corresponding to the visual impression, but merely a schematic visual concept of form. In that respect the visual transposition not only comprehends the form of the whole object, but is mostly limited to single successively touched parts. A synthesis in the visual sense is not achieved for the simple reason that the three-dimensional tactile image obtained through haptic examination of all sides cannot, as has been previously mentioned, be grasped visually as a unitary body.

"Here we have to make a reservation. Closer investigation shows that it is not the haptic *form*, but rather the *structure* as recognized by the sense of touch which becomes translated into visual terms. Hand in hand with the recognition of the structure of the tactile image or the tactile object the visual forms emerge by way of association. By reason of the association with structure the transformation of the haptically perceived image leads to schematic visual images. That is bound to be the case, for the structural image only allows of schematic sensory representation. Under certain conditions that structural transformation may occur so rapidly that one gets the impression of transformation of the haptic image into the visual one taking place directly. Accurate observations, however, reveal the

indirectness of the process. That the transitory phase is sometimes concealed and is occasionally in abeyance does not impair the general importance of that fact.

"Recognition of the fact that the visualization of the haptic perception of form is confined to a schematic form or structure does not constitute the ultimate stage of our insight into the matter. We may ask the further question why visualization takes place at all and why the haptic form, gradually apprehended through tactile investigation, does not suffice. In order to answer that question we must refer to what we have said before about the urge towards an exhaustive apprehension of form in the haptic sphere.

"To the sighted form means the visual formation of objects. To them the world is shaped according to visual principles. We are not able to get a correct idea of what we have never seen. In spite of the fact that we have touched our buccal cavity and our teeth with our tongue many times, we do not possess any clear idea of the form of these parts. If we could shape the haptically investigated objects by means of the sense of touch only, the impressions of form would remain only haptic structures and we should never obtain objects with clearly defined outlines and of individual character. Such typified form images can, however, hardly be fitted into the world of visual forms, from which we have gained all our general and special concepts and ideas about form. The tendency to visualize, constantly operative in those with sight, aims ultimately at transferring the haptic perceptions of objects into a sphere in which we feel at home and to which we owe our most important experiences of our spatial surroundings. These considerations give us a certain insight into the world of forms of the blind.

"Finally I should like to remark that the visualization of haptic data is also required for expressing *in words* what has been observed haptically. Whenever we want to make a statement on the form or structure of an object, we have almost exclusively visual terms at our disposal. The whole set of terms required for the presentation of spatial structures has its origin in the Optics of form; we are therefore compelled, so to speak, to make the haptic impressions of form visual," (pp. 152-4).

To compound the difficulties of the blind in constructing visual images are the numerous physical situations which are not at hand to be observed. That which is too small, too large, too far away, too hot, too cold, too disagreeable, or too dangerous to be sensed directly must be experienced vicariously. Someone else must have the original visual perception of the object and transmit his interpretation of it to the blind person through lingual, mathematical, or other symbolic communication. The subjective "fall-out" and augmentation which takes place through the processes of perception, interpretation, and communication are indeterminate. To repeat Révész, one cannot accurately visualize something he has never seen. It is the experience of active blind persons that they receive many false impressions through the interpretations of others. Such fallacies are detected by comparing the interpretations supplied by various observers and when the blind person is able to confront the reality of the environment and finds it different from the visual image he has carefully prepared from the data supplied by others. Experience has taught some to learn how to question informants carefully so as to avoid anticipated misinformation, inaccuracies, deficiencies, and distortions. Under optimal circumstances the best visual images would seem to be those which are fabricated from relevant visual memories gathered from past experiences.

Another important variable is the hypothesized decay of the ability to visualize following the loss of sight. Both Révész (1950) and Carroll (1961) state that the lack of

use of this ability can markedly diminish its functional value. So far as is known only subjective reports substantiate this hypothesis. That individuals are found without significant imagery ability is evident from the literature. However, no longitudinal studies covering the span of life before blindness, onset of blindness, and several years after blindness, are reported. A further conflicting concept is that of Révész (1950) who describes passive visualization.

"Passive visualization comes into being through the innumerable associations which are constantly established between the two sensory spheres during the whole of our individual life, and of which extensive use is constantly made. Although the two sensory functions are by nature devoted to different tasks, they constantly support and supplement one another. This interaction becomes very clear in the passive visualization of haptic impressions, but also in the passive process which gives visual perceptions a haptic character. Visual concepts accompany tactile activities just as tactile experiences accompany visual perception. In concrete cases it is difficult to decide whether and to what extent visual mental images are operative in tactile processes, because in the passive receptive attitude the sensory components of the whole of the experience are not perceived in isolation and because the retrospective reflection on which we have to fall back in that case cannot give us any reliable information about the truth of the matter, in view of the vague image created by the preceding sensory perception.

"The relatively easier visual *transposition* of haptic impressions is due to the fact that the visual sphere possesses a greater wealth of *co-ordinations* with the tactile sphere than vice versa. The basic haptic qualities of smoothness and roughness, and even the qualities of hardness and softness, have their phenomenologically corresponding correlates in the field of Optics, while the colors and differences in brightness are completely devoid of such correlates. It is thus natural that in haptic perception a sort of synthesis with visual notions should more easily occur than a synthesis with haptic notions in visual perception," (pp. 151-2).

This question would seem to warrant further study. In order to measure visual imagery activity in a longitudinal study it would seem to be necessary to identify a population, such as a group of patients suffering from diabetes or glaucoma for whom the onset of blindness is fairly predictable and whose prognosis for life is sufficiently long to permit the decay process to occur and be measured without contamination by such other factors as chronic brain syndrome.

REMEDIAL TREATMENT FOR THE ADVENTITIOUSLY BLIND

The literature supporting contemporary methodological approaches to the understanding, development, and application of visual imagery as a useful and essential cognitive process for the rehabilitation of the adventitiously blind is extremely sparse. As has been seen, a great deal of the speculation is based on subjective reports and rather superficial observations. Much too little has been done toward the completion and verification of a theoretical framework on which to base scientifically designed training programs for the orientation, mobility, productivity, and creativity of the blind. Standardized training procedures have been designed to meet these objectives and the justification for them is the demonstrable fact that they usually work. They are successful with some individuals because of a variety of intervening variables. The most significant variable would seem to be the predisposition of the individual to be able to imagine himself functioning adequately as a blind person. Thus a process of self-screening determines who will accept and who will reject the offer of rehabilitation treatment and training. Another variable exists within the family and professionals whose perception of the blind person's

behavior leads them to the conclusion that the kind of rehabilitation that is available might or might not be effective. Thus a second screening process takes place. Finally, selected trainees are given the prescribed program which is, admittedly, shortened or lengthened to meet the apparent needs of the individual as determined by his responsiveness to training. During the training process, the personality, sensitivity, insight, and skill of the trainers will vary the process as will the interaction between the trainee and trainer. The dynamics of the interpersonal relationships during the training are not readily subject to objective evaluation and never to objective measurement. Hence "a difficult case" may respond better in one training situation rather than another or with one trainer rather than another. If this critique of current practices is approximately correct, we are still operating on a pragmatic basis rather than a scientific basis.

Cutsforth and Wheeler (1922) shed a great deal of light on the degree of complexity of the problems involved in their study of the phenomenon of *synesthesia* which English and English (1958) define as "a condition found in some individuals in which perception of a certain type of object is regularly linked with particular images from another sensory mode. Thus, in colored hearing (chromesthesia) certain sounds regularly evoke imagery of certain colors, often spread out in space in a precise way. Number form is imagery of numbers in definite geometrical positions according to their serial order." This is a normal process whereby stimuli in one sensory modality evokes a "stereotyped" secondary response in another modality, usually the visual sphere. There is, then, a whole realm of psychic phenomenon of a specific kind which is related to the use of imagery but which is only poorly understood and virtually never investigated in the individual by the practitioner. It would seem to be important to know exactly what response is elicited by verbal as well as nonverbal content of a training program in order to obtain optimal behavioral responses through the modification of the training procedures in accordance with the individualistic cognitive processes of the trainee.

Another contribution was made by Cutsforth (1933, a) in a study of the relationship between tactual and visual perception, from which was derived twenty-six conclusions with various subconclusions. In general it was found that for sighted subjects there is an unvarying tendency to translate tactual perception into visual images with the reverse process a much less frequent phenomenon. The accuracy of visual reproductions of tactually-perceived geometric forms was subject to a great deal of variance. Certain tendencies to represent specific forms in a constantly deviated manner were noted. In judging sizes and shapes, subjects also reported "movement," that is they actually experienced a nonexistent change while trying to perceive the object tactually under certain experimental conditions. Another conclusion was that the various sensory perceptual modalities do not operate in isolation but are highly integrated processes culminating in cognition. Finally it was concluded that imagining is a cognitive process subject to a variety of phenomenological errors.

Subsequently, Cutsforth (1933, b), presented all of his findings to date. The focus of his book, *The Blind in School and Society*, was on the problems related to the understanding and professional treatment of the congenitally-blind child. In addition, he elaborated on the differences between the congenitally blind and the adventitiously blind regarding the development of spatial concepts and the utilization of the resulting different perceptual and cognitive processes. After having set forth the limitations of nonvisual perception of the world as experienced by the congenitally blind, he commented on the practical limitations of the visual imagery of the adventitiously blind in apprehending the contemporary environment:

> "Visual imagery of a decade ago is not adequate to cope with the visual world of today. For example, even clear visual imagery of the styles of dress ten years ago is of but little value in

imagining how the modern world is clothed," (p. 50).

"Neither the seeing nor the blind fully realize the difference that exists between their respective worlds of experience and reality. The seeing are scarcely aware of the fact that the greater part of their lives consists of visual experience, employing visual form, size, color, brightness, movement, and spatial distance. The blind are taught those concepts and how they are employed, and with the verbal mastery of them a workable parity appears to have been established between the seeing and the blind," (p. 48).

In the latter quotation, Cutsforth was referring to the congenitally blind specifically. However, the idea of two differential worlds of perception would seem to be equally applicable to the comparison of the sighted with the adventitiously blind. As the duration of blindness lengthens, as the cultural aspects of the environment change, and as the imagery phenomenon is modified, the adventitiously-blinded person's perceptions of the new environment must necessarily pursue a diverging course from the realities of the physical world. Contributing to the diverging perceptions is the dependency on language symbols for the communication of highly subjective experiences as if they were universally transmittable. Not only do the congenitally blind adopt verbal conventions because of social necessity but the adventitiously blind accept a multitude of partial understandings in order to maintain a facade of awareness which may or may not ever be achieved. The problem is further complicated according to Cutsforth when he speaks of "subversion of the objective methods." As he states, the ceramic frog may look like a frog but does not feel like one. Such an artifact utilized as a teaching device for the congenitally blind is a severe misrepresentation of a frog. If the object represented by a model is equally unfamiliar to the adventitiously blind person, comprehension of the reality represented may be nearly as greatly distorted as in the case of the frog. So far as the apprehension of the beautiful in the physical world is concerned, the adventitiously blind would seem to fare better with the development of a taste for tactual pleasantries rather than relying on the visual images as the only means of aesthetic satisfaction, since for them their haptic perceptions are their own subjective experiences. While it is "normal" and at least habitual to ask about the color and other visual characteristics of an object, the imagery evoked is derived from the perceptions of others and is subject to the aforementioned interpersonal subversion and intrapersonal aberrations.

CURRENT PSYCHOLOGICAL RESEARCH AND THE APPLICATION OF FINDINGS TO ORIENTATION AND MOBILITY

It can be derived from the foregoing statements of the problems relating to the study of the imagery phenomenon that a great many unwarranted assumptions are utilized in the instruction of the adventitiously blind during the rehabilitation process. Much of what now appears to be fairly well-founded knowledge does not seem to be of major concern to nor utilized by professionals in the field of rehabilitation of the blind. A cursory review of the contemporary literature dealing with the orientation and mobility of the adventitiously blind demonstrates a paucity of information regarding the psychological aspects. Investigations and articles have recently become abundant on the subjects of technological travel aid development and training procedures.

At the Rotterdam Mobility Research Conference (1965), under international sponsorship, a variety of papers were presented by speakers with quite divergent backgrounds and representing several applied and theoretical disciplines. Ideas and statements which are presumed to represent the psychological aspects of the content of the papers presented are cited below to demonstrate the areas and degrees of depth of thought represented in contemporary efforts to establish a scientific body of knowledge relevant to orientation and mobility. The

selections were chosen to demonstrate the diversity of opinion and thought with regard to the importance of imagery as it may or may not contribute to spatial orientation.

Riley (1965) discusses the training of blind persons in fencing as a conditioning process which contributes to mobility. He indicates twice in his paper that the activity develops imagery in the trainee who is forced to imagine the position and the moves of his opponent. However, much more emphasis seems to be on the gains made in developing kinesthetic and physical abilities than psychological factors.

Van Dyck (1965) describes skiing as affording even more recreational values than it does for the sighted. He mentions the development of the sense of direction as being a benefit and the ability to imagine the route of travel from careful instructions given by the trainer in advance of a downhill run. Practice seems to be the only technique used to develop imagery ability along with the necessary physical attributes.

Josephson (1965) in an attempt to deal with demography and market for guidance devices, points out that estimates of the number of blind persons in the United States vary from 400,000 to 1,000,000 persons depending upon the definition used and the source of the data. He also mentions that his study indicated that approximately 15 percent of blind persons queried had never had any kind of orientation and mobility training. Further he cites another study which indicated one percent of the blind are guide dog users with possibly one additional percent potentially capable of using guide dogs. In reference to travel aids which might be potentially useful, he says:

> "To go a step further, the problem is not just that we lack precise data about the number and characteristics of blind people but that we do not have enough information about their capabilities and their motivations to use the devices. Even if we knew more than we do about the demography of blindness, this would not tell us how blind people might cope with particular devices in everyday situations. It is just such longitudinal studies--that is, observations of blind people in action with a variety of devices over a sustained period of time--which are most needed. And I think I am safe in saying that there have been no such studies to date," (p. 128).

Graham (1965) calls for the development of readiness tests for mobility training as a means of making more effective use of the personnel, facilities, and knowledge available for the training of the adventitiously blind. Based on a subsample of 100 subjects from a group of 867 blinded veterans studied, he selected 12 case studies from which he concludes:

> "These cases suggest strongly that multiple factors are at work in the formation of a mobility pattern. Certainly these multiple factors would have to be considered in the formulation of any readiness test for mobility training. That mobility training programs are needed for blind and severely visually-impaired persons, especially for those with some remaining vision, the multiply impaired, and the old in good health, is often said. That some more rational procedure for selecting persons for mobility training is absolutely necessary is not said, nor is any need voiced for a performance test or tests of persons who have completed a mobility training program (a subject that requires separate consideration at another time). Until such tests are devised, experimented with, and standardized, it is not likely that there will be any successful attack on one of the two main problems facing blind and severely visually handicapped people today: mobility," (p. 142).

Clowes (1965) discussing mobility theory went somewhat further in that he suggested not only the need for psychological research but a particular field of interest as an example of research which might be applicable.

> "Research towards improving the mobility of blind people is very

heavily biased in the direction of improving the sophistication of existing transducers. Relatively little investigation of the human skills subsuming the effective use of such devices has so far taken place. It is usually assumed that the device will take--like a graft--provided that the display characteristics (e.g., its audio frequency range, discriminability, and so on) are correctly chosen. It can be argued, however, that in the absence of a clear understanding of the information processing being performed by a blind (or sighted) traveler, this choice (of correct display characteristics) will remain arbitrary or at best pragmatic. . . .

. . . I am quite convinced that the direction lies experimentally in the use of simulated environments as described by Professor Mann (2). I have an equally strong conviction that the framework lies in the descriptive systems currently being developed in research in language (1, 5). The conceptual framework of these linguistic models can readily be extended in an illuminating fashion to the study of apparently unrelated aspects of behavior, e.g., motor skills, problem solving, etc. (3) [p. 169].

The ideas briefly outlined above are of course highly speculative, and are included only so as to indicate the absence of any sustained research into the nontechnological aspect of sensory aids.

One of the important side effects which would flow from the development of an understanding of these psychological processes would be to bridge the gap between sensory aids research and vocational rehabilitation. Indeed it seems possible that a direct consequence might be to show (i.e., prove) that the main improvements in mobility are to be obtained from a redeployment of existing skills (based on hearing, tactile kinesthetic sense) rather than the proliferation of further transducers," (p. 170).

Chavanon (1965) in discussing psychological and technical aspects of guidance aids, made some rather obvious observations concerning blind populations he had observed and the limitations of a particular guidance device on which he had worked. However, his initial statement seems highly relevant here.

> "The problem of providing guidance aids for the blind has two different aspects, psychological and technical.
>
> The psychological aspect is the most important, for every blind person has different requirements according to his age, his sensorial abilities, his reflexes, and his physiological capabilities," (p. 199).

Kolers (1965), a psychologist reacting to the numerous papers dealing with the technological development of travel aids at the Rotterdam Mobility Research Conference, takes the designers to task for being preoccupied with the available hardware and the naivete of their approach to the orientation and mobility problems encountered by the blind. Among the ideas which he emphasized are the following:

1. Orientation in space, for the blind, is only a special aspect of orientation in space for the sighted.

2. There are two problems, the first is the problem of accounting for orientation in space generally, and the second is the exploitation of tools for accomplishing the end created by the plan, or mobility.

3. Auditory and/or tactile signals from current guidance devices are objectionable because of their interference with normal perception, because they supply much useless information, and because they presuppose that range information is the most useful data needed and that our perception of objects is built up out of a series of very primitive physical dimensions.

4. Perception is not dependent upon the physical dimensions measurable by guidance devices.

5. Perception is categorical, objects are seen in terms of their category membership or their set membership. That is, the object is named specifically and then assigned attributes.

6. Guidance devices must, to simulate perception, begin with linguistic categories, or with perceptible categories, with objects or things or the names of things.

7. No reported studies indicate what kind of information enhanced mobility, and what kind of information was of no use in mobility.

8. What characterizes the mobility of the blind is some higher order representation of the environment. Images, maps, or schemata are the basis of not only blind perception but of sighted perception about which very little is known.

9. Within the schemata, landmarks are very important to the identification of position in space or orientation.

10. The blind must also carry about some image of the environment, some representation of the environment. It should be known how this representation is formed, how it can be enhanced, how to make it flexible to accommodate variations in the environment.

11. The principal way images are formed is through action. The repetition of a series of actions a sufficient number of times forms a vivid image of this set of actions.

12. Three different representations of objects or events in the environment are posed:
    a. the representation that comes from contact;
    b. the higher order representation that permits one to operate on an image;
    c. the representation, beyond imagery, where the behavior exists in its own right as a "unit."

These propositions seem to give some concrete suggestions as to the direction future research should take. The works cited by Kolers are significant steps towards a new beginning in understanding the cognitive processes underlying that which we call *orientation* and that which is necessary for the advancement of mobility training, the development of useful guidance devices and all other activities dealing with the physical environment which are of concern in the rehabilitation of the blind person. If the findings and assumptions contained in this paper and elsewhere are to have useful application and stimulate further study, educators, trainers and researchers must not only know of them but utilize them. Without due consideration to individual differences and without the application of scientifically derived findings, ineffectual or wasteful research and rehabilitation efforts will continue to prevail.

To belabor the absence of interest and findings in the psychological area related to orientation and mobility, the proceedings of the *Conference for Mobility Trainers and Technologists* (1967) were reviewed and a remarkable lack of psychological concern was found. Only cursory attention was paid to this aspect by the designers of technical aids who generally limited their remarks to preferred types and modalities of input signals with slightly more attention to the amount of data which could be utilized by the subject through given channels. In other words their concern continued to be with the detection of obstacles and range-finding instrumentation.

In discussing the development of the mobility programs which use canes alone as travel aids, Williams (1967) pointed out to the conference that systematic approaches cannot be documented before World War II. He also elaborated on the resulting improvement of the cane through the application of modern technology to this ancient tool of the blind. His major psychological point was that the attitude of the blind and the public toward the acceptance of the cane as a necessary and useful tool has changed during the past two

decades. The cane, when presented in a rehabilitation setting, is no longer necessarily a symbol of blindness but can be an indispensable aid to independence. Although no attitudinal studies are cited, Williams feels that the programs of the agencies for the blind through publicity and demonstrations have changed the public's perception of the "white cane" from a symbol of disability to one of ability.

Speaking from the point of view of an educator of orientation and mobility trainers, Blasch (1967) reported to the conference on the expansion of orientation and mobility training to children and the aged through the increased availability of qualified personnel. He referred to the need for modified techniques to develop *concept formation* in the congenitally blind and to overcome the problems of the aged including decreased motivation for mobility. Without stating how these essential objectives are to be accomplished specifically, he did indicate that somewhat different qualifications of the trainers might be helpful in working with older people. He provided the conference with an excellent overview of the expanding age spectrum requiring services and indicated the relevant problems and assumed group limitations.

In presenting the conference an interpretation of *pre-cane techniques*, Blaha (1967) described them as "Basic Techniques Essential to Orientation and Mobility." He, like others, emphasized the initial phases of training as highly important to concept formation. For the young to whom the world is new and for the old who may be wary of its dangers, he stressed the need for careful and intensive basic training in negotiating the inside environments such as are found at home, at school, and at work. While not explaining techniques used to develop concepts of spatial relationships, he emphasized the importance of experiencing the environment through the available sensory modalities and having sufficient practice with it to achieve the necessary knowledge and confidence required to operate effectively. He reiterates that the blind person must know his environment in order to be motivated to move about and to experience the satisfactions and self-esteem resulting from a good performance which will make positive impressions on observers who will in turn treat the blind individual with the appropriate respect for his ability.

The conference was enlightened by Suterko's (1967) review of the advantages and problems encountered in long cane training. He chose to conceptualize his presentation of the use of the cane as a three-unit system consisting of man--the key unit, the cane--a perceptive tool, and cane technique--or the scanning method. He, too, emphasized the necessity of the dichotomy: orientation as the process of establishing one's relative position in the environment, and mobility as the locomotion of the individual from one place in space to another. He acknowledges the primacy of man in his three unit system. He dwells at length on alternative sensory modalities for orientation, individual differences, and inadequate psychological knowledge. He made a significant contribution by pointing out the importance of biomechanical factors in human locomotion and the need for further study in this area. He finds little fault with the "typhlostaff," a commonly used long cane, but did suggest improvements regarding weight, conductivity, and glide ability. He regards the third unit in the system, the scanning method, satisfactory for the detection of environmental variables below the waistline. However, he invited the technicians to study the scanning method for any possible improvements and to study alternative perceptual tools which would detect obstacles above the waistline without offering auditory or other conflicting sensory input.

Reviewing his own area of investigations of the cane as a channel for the communication of information, Foulke (1967) told the confreres of his efforts to refine and develop several canes, some of which have been previously tried but found wanting in a few respects. He reported attempting to define criteria for optimal performance on several variables. He emphasized the necessity of maintaining a scientific orientation with regard to possible innovations, citing his own work with a

caster tipped cane as a derivation of the long scoffed at wheeled cane. For the more scientific evaluation of travel aids. Dr. Foulke has experimented with and hopes to develop a model environment which would include typical characteristics and which would provide a standardized measure of performance of the cane, method of use, and of the individual user.

The measurement of performance of travel skills was discussed by Leonard (1967) and Wycherley (1967) who described to the conference their work on the development of a set of criteria and standards for travel skills resulting in fourteen dimensions. The Shrewsbury experiment was reported as an effort to verify and develop the aforementioned rating instrument. The actual performance of blind subjects utilizing a short cane over an unfamiliar route was observed, recorded, and interpreted. From this experiment, data was generated supporting the assumption that a standardized travel pattern could be used for the selection, diagnosis, and remedial training of candidates for mobility training. The authors were not concerned with the psychological dynamics underlying the behavior but focused on the actual performance of a heterogeneous group of blind students who had had various amounts of orientation and mobility training.

In an effort to identify the manifest problems of the blind in spatial orientation and mobility, Cratty (1968) performed extensive experiments utilizing young blind subjects. He measured the tendency to veer from a straight course, deviate in degree of prescribed rotation, detect vertical gradients and curvature of course. He found some difference between sighted and blind subjects. Further, he found that error could be reduced significantly by training. He concluded that early training of a specific kind could improve the readiness of the child for mobility training even though he does not deal with isolated sensory, perceptual or other cognitive processes, preferring to concentrate on the practical aspects of the behavioral response. More recently Cratty (1971) has published a volume setting forth a variety of remedial procedures which can be used by parents, educators and trainers to facilitate spatial orientation and mobility. He emphasizes the need for further disciplinary research and clinical application toward the solution of the psychological problems which he acknowledges to be of more importance than defects in physique or inadequacies of mobility aids. Again implicit in his work is the assumption that the body image and the images of the external world are essential and must be formulated accurately during the developmental process.

Rice (1970) provides a comprehensive review of the experimental evidence, a review of his own highly controlled psychophysical studies and his sophisticated conclusions regarding the ancient question as to whether the blind compensate by the enhancement of other senses. Perceptual enhancement occurs under appropriate conditions. The latter conclusion is supported by his work with blind and sighted subjects in which the task was to identify the presence or location of targets utilizing "human sonar." In addition to the excellent data, Rice and his colleagues have presented a demonstration of the application of vigorous scientific methods to the study of complex human behavior. Having worked with auditory perception as the major experimental variable, he concludes that sensory activity alone is not the determining factor in superior performance. Having analyzed the histories of his subjects, he concludes that appropriate environmental stimulation during critical developmental stages must account for above average performance. He demonstrates that there is great variation in individual differences on the important dimension of obstacle detection as it applies to orientation and mobility. The implications before the improvement of training methods are obvious since good diagnostic data on all relevant variables can increase the accuracy of performance expectations and suggest remedial and alternative training techniques.

CONCLUSION

Having cited the conclusions of numerous experts it seems redundant to attempt to again draw together a listing of the areas of knowledge

and areas of inadequate knowledge regarding the function of imagery in the congenitally and adventitiously blind. The foregoing pages would seem to adequately reflect the state of the art at this writing. It is by no means a field in which little of practical verified information exists. However, the knowledge stems from work in diverse fields, is not widely known or understood across lines of professional disciplines, and is nowhere drawn together in a comprehensive volume purporting to provide a theoretical framework supported by research and clinical data, and setting forth the ways and means of using the knowledge. Thus, researchers and practitioners are forced to engage in time consuming and repetitious reading and the promulgation of their own working hypotheses in order to arrive at their own systematic methodology. The next step would seem to be a compilation of the data in a form which would be useful to scientists, technicians, and practitioners who wish to advance their own work through the application of psychological knowledge toward the end of developing further insights. Admittedly, the imagery phenomena in the various sensory modalities are and will continue to present some of the most knotty problems to be studied in the area of the cognitive processes, but should be a field of study yielding much reward to the investigators and benefit to the blind.

Part III
Imagery Tests and Experimental Instruments

INTRODUCTION

An attempt has been made to locate and identify those psychometric instrumentalities and procedures which explicitly or implicitly appear to be potential measures of the imagery ability in human subjects. Animal studies have not been included. The growing literature on brain wave studies utilizing the electroencephalogram and subjective reports of EEG subjects have not been emphasized because, while they have peripheral importance and are of interest, they are not particularly germane to this review.

The "tests" reported below do not appear in a consistent form since the original sources were not always consistent in the information supplied and the unavailability of much of the material in its original form made it necessary to rely upon secondary references. Many of the published tests and experimental instruments described do not report useful or substantiating data on norms, reliability, and validity. To the extent that such standardization information was available, it is reported as found, or the original source is cited. For the convenience of future investigators, an attempt has been made to identify the variables presumably measured, describe the apparatus used, brief the testing procedure, and report the original investigators' findings.

The "tests" have been dichotomized, for the convenience of the reader, under the headings of *Subjective Tests* and *Objective Tests*. Subjective tests here are defined as those tests which elicit verbal or nonverbal responses to ambiguous stimuli which are not immediately available to the examiner for comparison with the response. Betts' test is a pertinent example in which the subject is asked to form an image of a common and frequent perception and to respond by rating the *vividness of the image* on a seven point scale. Objective tests are characterized by the presentation of measurable stimuli and the requirement of the subject to respond with verbal or nonverbal behavior, the coincidence of which can be measured in relation to the critical physical measurements of the stimuli. Juurmaa's test of *Kinesthetic Memory* exemplifies this type in that the subject grasps handles on a pivoted rod and experiences movement of the rod through a pre-determined arc under the supervision of the examiner. The subject then responds by repeating that prescribed motion which is recorded by a hidden pointer moving over a scale calibrated in degrees.

Unfortunately, the limitations of time and personnel did not make it possible to exhaust all of the potentially fruitful reference material which might yield further tests and experiments on or related to imagery. All potentially helpful references were pursued as far as possible and do appear in the accompanying bibliography although the original source was not accessible. It will also be noted that tests and experiments relative to imagery in all of the sensory modalities are not equally represented. The technical difficulties to be encountered in test construction undoubtedly accounts for the absence of instruments to measure imagery ability in the modalities of olfaction, gustation, pain, and the cutaneous senses.

SUBJECTIVE TESTS OF IMAGERY

ANGELL'S "SUGGESTIONS FOR IMAGERY TEST CONSTRUCTION"

Twelve general categories of tests are described as potential instrumentalities for the measurement of various mental faculties, all of which presumably include imagery. The various senses are included, as are original and borrowed techniques. All responses relied upon introspection. No precise testing format is prescribed, nor is there substantiating data on reliability and validity. Angell, J. R., 1910.

"BETTS' TEST OF VIVIDNESS OF IMAGERY"

A subjective investigation of voluntary imagery groups of subjects varying in degree of sophistication were asked to rate individually on a seven-point rating scale images associated with 150 stimulus items of a questionnaire. It concerned all modalities. Frequency of occurrence of vividness ratings and correlations between the degree of vividness of imagery of one kind with another were noted. Betts, G. H., 1909.

"THE BETTS-SUTCLIFFE TEST OF VIVIDNESS OF IMAGERY (SHORT FORM)"

The Betts test of vividness of imagery has been subjected to a psychometric analysis, and pending cross-validation a shortened form is available for use in reporting subjective responses to verbally presented stimuli. Sutcliffe, J. P., 1962.

BROWER'S "THE EXPERIMENTAL STUDY OF IMAGERY, II: THE RELATIVE PREDOMINANCE OF VARIOUS IMAGERY MODALITIES"

Student subjects responded by writing to oral questioning concerning images aroused by reference to onions frying in a pan. The resulting images are reported as in the order of diminishing frequency: visual, auditory, tactual, kinesthetic, thermal, olfactory. Brower, D., 1947. *Psychological Abstracts*, 1948/2952. (b)

DAVIS' "THE FUNCTIONAL SIGNIFICANCE OF IMAGERY DIFFERENCES"

"The purpose of this investigation was to 'determine to what extent differences in subjects' reports as to their use of imagery in the performance of given tests are related to objective differences in test scores.' The subjects were students in an elementary psychology class. It was found that reports as to manner of performance of various intellectual tasks, under stated conditions of experimental control, were supported to a considerable degree by objective results in the form of differences in test scores correlated with differences in the subjects' reports. Correlations with intelligence as measured by Army Alpha were. . . positive and low. No reliable or consistent sex differences were found." Davis, 1932, *Psychological Abstracts*, 1933/4308.

FERNALD'S "THE DIAGNOSIS OF MENTAL IMAGERY"

She concluded, "In every case our dependence was on the subject's introspection--either the tests were purely subjective or a combination of subjective and objective."

Subjective. Reading tests, solving arithmetical, geometrical, physical or other problems, rhyming tests, majority of memory tests, problems in motor control, such as drawing, many of the distraction tests.

Subjective and Objective. Spelling backwards, and pronouncing from words spelled backwards, description of pictures from memory, memory tests with words similar in appearance but not in sound and vice versa, sorting and matching colors, and certain of distraction tests.

Objective. None to offer as satisfactory. Fernald, M. R., 1912.

GALTON'S QUESTIONNAIRE

This was designed to identify the illuminations, definition, and coloring of the mental image. He found that scientific men, as a class, had feeble powers of visual representation and that women possessed a higher power of visualizing than men. He concluded that the visualizing faculty is a natural gift and that it could be developed by training and practice. He found very little relationship between high visualizing power and the intellectual faculties. (See French [1902] for experimental data using Titchener's revision of Galton's Questionnaire.) Galton, F., 1907.

GRIFFITTS' A TEST OF "CONCRETE IMAGERY"

This consisted of 130 words and phrases to each of which the

subject responds with a mental image. Griffitts, C. H., 1937.

KLUVER'S "AN EXPERIMENTAL STUDY OF THE EIDETIC TYPE"

"Kluver is concerned with a phenomenological description of the imagery of 27 adults and children of the eidetic type. Many types of visual situations are used to arouse the imagery of the subjects. The results are summarized separately for each type of material used." Kluver, H., *Psychological Abstracts*, 1928/56.

KRAEPELIN'S "COLOR VERSUS AUDITORY IMAGERY-TYPES TEST"

Subjects are asked to write for five minutes lists of words designating objects primarily categorized by color, and in another five minutes objects primarily related to sound. When compared, the lists are supposed to indicate the scale of distribution for different kinds of imagery, the dominant type being represented by the most extended list. No reliability or validity was claimed. Kraepelin, E., 1895.

LEUBA'S "IMAGES AS CONDITIONED SENSATIONS"

"Two stimuli, such as the ringing of a bell and a pin prick on the hand, were applied simultaneously to subjects while they were under deep hypnosis. Before being awakened the subjects were told that they would remember nothing that had happened during the hypnosis. A few minutes after being awakened they were subjected to a succession of stimuli among which was one of the two stimuli originally applied (bell); they were instructed to report at once if they experienced anything besides the usual direct effects of the stimuli. Almost without exception images (conditioned sensations) were immediately reported upon presentation of the conditioned stimulus. After ringing of the bell, the subjects reported itching and pain on the hand, although there was no recollection of being pricked there or of having ever heard the bell." Leuba, 1940, *Psychological Abstracts*, 1940/2983.

KUHLMANN'S MEMORY OF PICTURES TEST 1907

". . . The five subjects used were asked to commit a series of pictures to memory. Recall required the subject to describe how he memorized them, giving the order and nature of imagery for each of the pictures. A. . . finding was that the imagery, with the lapse of time, tends toward features attributed to the stimulus by the subject whether originally present or not." Sutcliffe, 1962, 227-228.

MARTIN'S "PROJECTION METHOD"

The subject was seated at a table on which was placed in turn a flower pot, a postal card of a landscape, etc. The subject was directed to place a visual image of the object at its side. If able, he was then to give his introspections to the examiner, and was questioned on points calculated to throw light on theories regarding the difference between the perception of a real object and its image.

Series I. Experiments were made to ascertain:

1. whether images are projectable into space at will; if so,

2. whether so projected they are amenable to examination, and

3. if anything is gained by having images so projected.

Series II. This was to learn whether the projection method can be advantageously employed in studying the difference between memory and imagination.

Series III and IV. Tests were made to show that the method is applicable to the study of illusion, hallucinations, etc.

Series V. This series was to ascertain whether the projection method can be used to advantage in

investigating auditory memory and imagination, illusions and hallucinations. Martin, L. J., 1911.

R. E. MILLS "LEARNING METHODS TEST"

Used by the remedial teacher as an aid in determining the most effective method for teaching specific children new words. Grades Kgn., 1, 2, 3; 1954-55; comparative effectiveness of four methods of teaching new words: visual, phonic, kinesthetic, combination; individual; . . . procedure consists of a pretest to select 40 unknown words, a 15 minute training session on each method, and post-tests of immediate and delayed recall for each method. Eighty-five to one hundred minutes in five sessions for pretest, training and post-tests. Robert E. Mills, Mills Center, Inc., Buros, O. K., 1965, (pp. 1122-1123).

MURRAY'S "GEOMETRICAL FORMS TEST"

For immediate memory for the study of stimulus variables--novelty, complexity, affective value, etc.--a subjective study. Murray, E. A., 1906.

SCHLAEGEL'S MODIFICATION OF GRIFFITT'S TEST OF "CONCRETE IMAGERY"

Subjects were 67 Blind School students and 78 sighted adolescents. This was an effort to determine the role of visual acuity and age of onset of incapacitating visual loss in the imagery employed.

Method. There was presentation of a large number of verbal stimuli to which the subject was asked to form an image in some modality.

Findings. "1. Present visual acuity. Those subjects with the poorest vision had the least number of visual, and the greatest number of auditory, responses. As the visual acuity (at Blind School levels) increased, there was an average increase in visual imagery responses to an extent even greater than that of normal controls. 2. Age of onset of incapacitating loss of vision. If the onset was before the age of six, visual imagery tended to disappear, being most pronounced in those subjects with the poorest vision." Schlaegel, T. F., Jr., *Psychological Abstracts*, 1954/28.

TITCHENER'S "QUESTIONARY UPON IDEATIONAL TYPE"

Based on Galton's test, items were added from the works of a number of investigators whose tests put more emphasis on the nonvisual modalities. The method was to present verbal stimuli to which the subject wrote descriptive statements concerning the vividness and modality of the imagery evoked. The items were categorized as follows: visual, auditory, tactile, gustatory, olfactory, thermal, motor, pain, organic, and emotions. For the actual items attributed to Titchener see "The Mental Imagery of Students," French, F. C., 1902.

OBJECTIVE TESTS OF IMAGERY

BARRATT'S "USE OF THE EEG IN THE STUDY OF IMAGERY"

An experiment was designed to test the hypothesis that suppression of the amplitude of the alpha rhythm provides a reliable objective index of visual imagery under two conditions of problem solving, namely, solving a verbal problem and solving a visual problem. Sixty-nine subjects were examined in the following way: First, preliminary "runs" were made with each S for EEG recording under two conditions: (a) eyes shut, relaxed; (b) eyes open. Second, EEG recordings were made under conditions (a) concurrently with solution of the verbal-reasoning problem and (b) concurrently with solution of visual-reasoning problem. It was found that suppression of the alpha rhythms occurred under both conditions. There was however, a greater suppression effect in the case of the visual problem. It was found that suppression of the alpha rhythms occurred under both conditions. There was however, a greater suppression effect in the case of the visual problem. The results suggest

that the hypothesis is not tenable since "imagery" appears to be only one of many factors that may produce suppression results. This conclusion is supported by a breakdown of the S sample which showed that there was no difference in the basic patterns as between those who visualized the verbal pattern and those who did not. Barratt, P. E., 1956.

BEAN'S "USE OF VISUAL, AUDITORY, AND KINESTHETIC IMAGERY IN THE TRANSFER OF MUSICAL NOTATION TO THE PIANO KEYBOARD"

Using music students as subjects the following experimental procedures were scored:

1. The Seashore Tonal Memory and Rhythm Tests;

2. The Seashore Test notes were presented visually on cards;

3. Seashore's tones were reproduced on the violin along with the presentation of a card with a series of notes;

4a. Tones were presented to the subject who was asked to depress the corresponding keys on a silent keyboard;

4b. Rhythms were presented by means of a telegraph key to which the subject responded on another telegraph key;

5. Rhythmic patterns were presented on a card to which the subject responded on a telegraph key.

Bean concluded that:

1. For a majority of the subjects visual imagery was clearest and used most frequently.

2. None of the readers could translate seen notes into mentally heard tones.

3. The best readers had high scores on all the tasks, except the tonal series in part four.

4. For reading situations, a note on the page meant to a majority the act of pressing a key, not a sound. Bean, K. L., 1939.

BERG'S AND WORCHEL'S "SENSORY CONTRIBUTIONS TO HUMAN MAZE LEARNING; A COMPARISON OF MATCHED BLIND, DEAF AND NORMALS"

Subjects were tested for learning and relearning on two high-relief finger mazes. One was a multiple U-maze reported by previous experimenters to involve motor and visual imagery. The other was an X-maxe reported by previous workers to involve verbalization in its solution, other sensory processes being ineffectual. Results indicated that the normal and the blind groups were equivalent on trials and errors in solving the task. This finding showed that visual imagery was not necessarily elicited by the multiple U-type maze. Verbalization was found to play a significant role in the U-type maze situation. On the X-maze, normals did better than the blind and deaf subjects. While verbalization was again important, visualization aided, as was seen from the superiority of performance of the late-blinded subjects over the congenitally blind. Berg, J. and Worchel, P., 1956.

CRATTY'S "THE UCLA MOBILITY ORIENTATION TEST"

"A survey of the findings suggested that two simple assessments might aid peripatologists to identify some of the basic perceptual attributes of the blind. With this in mind, two simple procedures were developed based upon the normative data collected in this investigation. One of these was developed to evaluate the veering tendency, the expected accuracy limits when attempting to walk a straight course without vision. The second was devised to evaluate the perception of gradient. Thus, the first one should determine how accurately persons can perceive their direction when attempting to walk a straight pathway in a horizontal plane, while the second attempts to determine the accuracy with which an individual can judge the shape of a pathway walked in a vertical plane. These tasks are presented as only two of several possible evaluative procedures which might be utilized prior to and at the completion of mobility training programs. Additional ones will be

added to these, and the administration and the scoring of these two will be modified when additional data become available.

"Several criteria governed the selection and administration of these two tests: (a) The expense of their administration is kept to a minimum, (b) Only perceptions relative to locomotion are surveyed, (c) Measurement procedures are simplified, (d) A minimum of equipment time, area, and apparatus is needed," Cratty, B. J. (1965).

CUTSFORTH'S "AN ANALYSIS OF THE RELATIONSHIP BETWEEN TACTUAL AND VISUAL PERCEPTION"

The purpose of this experiment was to ascertain how nearly ten trained and 120 naive subjects could reproduce a rectangular figure visually while observing a stimulus block tactually and to ascertain quantitative and qualitative modes of deviants. The apparatus was designed to enable the subject to manipulate the size and shape of the visual rectangle while examining five three-dimensional rectangles one at a time inside of a box which obscured the stimulus item from view. The assumption was that the subject would form a visual image from the tactual examination of the block which he would then try to reproduce by manipulating the visual rectangle. Twenty-six conclusions were derived from the findings supporting the idea that the visual and tactile motor-perceptual functions are interdependent and cannot be considered as isolated functions. Cutsforth, T. D., 1933. (a)

DAUTERMAN'S "STANFORD MULTI-MODALITY IMAGERY TEST"

The *multi-modality* aspect of this test rests on the nature of the tasks to be performed during the two learning phases. Since the congenitally blind cannot have the visual mode of imagery available to them and since individual differences in imagery abilities are known to exist, tactual, kinesthetic, and verbal stimuli are introduced as potential means of imagery stimulation. This is done by the use of tangible apparatus which is manipulated by the subject as he follows the verbal instructions from the examiner.

Since the test method chosen is a measure of imagery involving geometric patterns and since it seemed obvious that any sample of the blind population would contain persons whose training and experience with geometric spatial relationships would be quite different, several special techniques were introduced as "learning phases" in order to compensate for the differences between those blind persons who may have had some experience with geometric relationships and those with virtually no practical experience.

The test now being used has three phases, the first two of which are the learning phases and involve the subject in the construction of simple three-sided and four-sided figures by placing rubber bands around a piece of fiberboard.

Phase I. "Comprehension and Following Instructions" is simply to give the blind subject an opportunity to familiarize himself with the tasks involved in the imagery test. The subject is allowed to manipulate a small fiberboard rectangle, and to place rubber bands around it in such a manner as to create various three-sided or four-sided figures within the boundaries of the original rectangle. At this level of learning, verbal descriptions as to what should be done are used. However, actual manual instruction can be introduced to enable the subject to achieve the necessary performance level before proceeding to Phase II.

Phase II. "Conceptualizing Spatial Relations" is calculated to introduce the concept of the construction and comprehension of the complex designs and their spatial relations within the basic rectangular figure. The subject is asked to place several rubber bands around the fiberboard rectangle and to ascertain whether there are three-sided figures, four-sided figures, or both types of figures in the pattern thus created. Four such "tests" or exercises are used in this phase and it is assumed that the more difficult aspects of pattern recognition, imagery, and retention are introduced at this level while the

actual pattern remains available to a subject for tactual inspection. As in Phase I, the experienced examiner may elect to use Phase II as a simple learning device with which to acquaint the subject with vocabulary and general nature of the test, but also may elect to use it as a teaching aid in preparing the completely naive subject for the more difficult tasks presented in Phase III.

Phase III. "Verbal Descriptions." At this level of performance it is assumed that the necessary vocabulary, awareness of spatial relationships, and imagery in some modality have previously been identified as being functional to at least a minimal degree. The third phase of the test requires the subject to construct images of geometric patterns from verbal instructions without the use of physical paraphernalia. The subject is asked to respond to the question, how many three-sided and how many four-sided figures are created in this geometric pattern. There are ten patterns ranging from a simple rectangle with one diagonal to a rectangle divided into sixteen three-sided and two four-sided figures. There was no assumption that the levels of difficulty between Phases I, II, and III were equidistant or that even the same physical and intellectual modalities were necessarily employed or measured.

The standardization study data indicates statistically significant correlations for construct and concurrent validity. That data was based on a total adult population of 202 legally blind subjects. Predictive validity utilizing a mobility instructor's rating scale was not adequately established but was presumed to be potentially higher than could be demonstrated by the data on 50 subjects obtained from a variety of instructors whose training and relationship to the subjects were not comparable. Dauterman, W. L. (1971).

DAVIS' "A MEASURE OF FUNCTIONAL DIFFERENCES IN IMAGERY MODALITIES"

Purports to differentiate among individuals who are able to function well in activities requiring the use of a sensory modality in which they also have superior imagery ability. Davis, F. C., (1932).

DREVER'S "SOME OBSERVATIONS ON THE OCCIPITAL ALPHA RHYTHM"

"In order to test the hypothesis that the disappearance of the alpha rhythm during mental work is associated with the use of visual imagery, occipital EEG records were taken from groups of early blind, late blind, and sighted subjects during the performance of two spatial tests. Since the test scores differentiated between the groups it was argued that the performance probably involved a visual component. When the subjects were classified into the three suggested alpha rhythm types, M, R, and P, the groups so obtained did not differ significantly from one another in terms of test scores. This was regarded as negative evidence so far as the hypothesis under investigation is concerned, especially since the alpha rhythm type supposedly associated with prevalently visual imagery was found most frequently among the blind." Drever, J., 1955. *Psychological Abstracts*, 1956/2034.

DURAN AND TUFENKJIAN'S "THE MEASUREMENT OF LENGTH BY CONGENITALLY BLIND CHILDREN AND A QUASIFORMAL APPROACH FOR SPATIAL CONCEPTS"

"This paper has endeavored to do two things: to present a quasiformal approach and point of view for investigating spatial concepts; and to describe and experiment inculcating this point of view. In the quasiformal approach the behavior of an organism or machine is differentiated into four parts: input, memory, logic, and display. This point of view is applicable to the sighted, blind, deaf, and so on. The experiment has yielded several valuable conclusions concerning abilities of blind children, and the application of these conclusions to the teaching of blind children was discussed. The major classes of methods for measurement of length by congenitally blind children are: juxtaposition and noncoincidence of endpoints, body part as a measuring instrument, kinesthesis, time duration, and physical principles.

The principle conclusions are:

"(a) The physical size of the objects will determine the technique used for the measurement.

"(b) As the physical length of the object increases, the corresponding DL increases independently of the technique used." Duran, Peter and Tufenkjian, Sylvia, (1970).

GALTON'S "INQUIRIES IN HUMAN FACULTY AND ITS DEVELOPMENT"

This instrument seems to have asked subjects to imagine an object while looking at a blank piece of paper, and to have asked them to trace the image with a pencil. He found the subjects to differ in their ability to do the task, and some to be able to improve their performance through practice. Galton, F., (1919).

GOMULICKI'S "STYLUS AND WALK-THROUGH MAZES"

Two comparable mazes, differing in size, were utilized. Both blind and sighted subjects were tested. Less carry-over learning was found when the small maze was learned first. Blind subjects did better than sighted subjects learning the walk-through maze. Gomulicki, B. R., (1961).

GORDON'S "AN EXPERIMENT CORRELATING THE NATURE OF IMAGERY WITH PERFORMANCE ON A TEST OF REVERSAL PERSPECTIVE

A visual stimulus was presented to the subject who was then asked to reproduce the item from merely the memory image, but to reverse the perspective in the reproduction. The correlation suggested an identifiable and reliable link between the nature of imagery and objective events. Gordon, R., (1951).

HUSBAND'S "ANALYSIS OF METHODS OF HUMAN MAZE LEARNING"

"To study 'internal' aspects of the learning process, a four-section multiple-U high relief finger maze was set as a task for blindfolded adults; the subjects were divided into four groups of 80 each, practicing on 1, 2, 3, and 4 sections, respectively. It was found that three qualitative methods were used in the learning (verbal, motor, and visual) as well as combinations of these; and that individuals sometimes shifted from one method to another. The verbal (counting) method was used by the greatest number of subjects, the visual (imagery) by the fewest. As measured by learning scores, the verbal was found to be the most efficient, and the motor least so. Transfer effects (between finger and stylus mazes) and savings on relearning were also studied. Much of the high variability which has always characterized maze results was found to be due to the many different methods used in learning, and it is urged that learners should have careful coaching in best procedures." Husband, R. W., 1931. *Psychological Abstracts*, 1932/168.

JUURMAA'S "CUBES TEST OF SPATIAL ABILITY"

"The subject had to build cubes from separate wooden parts, which could be joined together with pegs and holes. Each cube had three to five parts. There were seven test items; before the test the subject had to assemble one cube for training. Times required for each item were recorded; the maximum time recorded for any item was four minutes. The final variable was the sum of the times required for each item."

Subjects were 228 individuals with varying degrees of visual disabilities and covered a wide age range. Sixth-three sighted controls also were used. Juurmaa, J., 1967, (pp. 26-27).

JUURMAA'S "KINESTHETIC MEMORY TESTS"

Utilizing relatively simple apparatus consisting of a pivoted bar and a calibrated scale, subjects were given tasks presumed to measure five differential variables. Only the upper extremities were involved in movement during the experiments.

Test 1. "Search." Subject is required to return the bar from the

horizontal position to a previously experienced position.

Test 2. "Returning to horizontal position." Beginning from large angles the subject was asked to return the rod to the horizontal position.

Test 3. "Returning to vertical position." Same as above, except that the rod had to be placed in vertical position.

Test 4. "Bisecting the right angle." Beginning from the horizontal position the subject attempted to locate the 45° position.

Test 5. "Turning." The subject followed the rod through a prescribed arc which he was then asked to repeat a number of times.

"Most of these variables had such low reliabilities (of the order of 0.20 to 0.40) that only the search variable was concluded in the study reported here. This variable represented kinesthetic mastery of and memory for hand positions."

The subjects consisted of 228 individuals with varying degrees of visual disabilities and covered a wide age range. Sixty-three sighted controls were also used. Juurmaa, J., 1967, (pp. 29-30).

JUURMAA'S (MODIFICATION OF KOHS' BLOCK DESIGN TEST), "SQUARE TEST OF SPATIAL ABILITY"

"In the square test the subject had to form a square similar to the model pattern presented to him. In the model pattern the square was a figure with a rough surface on a smooth ground. The subject was given three kinds of small aluminum plates: squares with a rough surface, squares with a smooth surface, and squares divided diagonally into a rough and a smooth half. There were twelve items; in the first six items four small squares were required and, in the following six, nine small squares. This test was based on Kohs' Block Design Test and the variants of this test developed by Dr. Hakkinen (Institute of Occupational Health). The times required to perform each item were recorded; the maximum time recorded for any item was four minutes. The final variable was the sum of these times."

Subjects were 228 individuals with varying degrees of visual disabilities and covered a wide age range. Sixty-three sighted controls were also used. Juurmaa, J., 1967, (p. 27).

JUURMAA'S MODIFICATION OF THE MINNESOTA-TYPE VISUALIZATION TESTS OF SPATIAL ABILITY

"The subject had to fill a square hole measuring 5 x 5 cm with aluminum bits. There were sixteen items, and the bits were numbered 2 to 4 depending on the item. In addition, each subject had to perform two training tasks. The time required to perform each item was recorded; the maximum time recorded was three minutes. This modification of the Minnesota-type Visualization Tests was designed for the blind. It is generally difficult to devise tests of this type that are sufficiently reliable. The situation is improved, however, if the number of bits per item is not very large. The final variable was the sum of the times required for each item."

Subjects were 228 individuals with varying degrees of visual disabilities and covered a wide age range. Sixty-three sighted controls also were used. Juurmaa, J., 1967, (pp. 26-27).

JUURMAA'S "ROLLING TEST"

"This was another group test of visual ability. The subject was presented ten different geometric figures. One point of each figure was indicated with an *x* sign. For each figure the subject had to imagine that it was being rolled along a horizontal plane so as to make one side after another coincide with the plane, and he had to make out the shape of the path traveled by the point marked with *x* when the figure was rolling. To form a concrete picture of the situation, it was suggested that the subject imagine, for example, that the figure

represented a pin perpendicular to the wall. The path traveled by the point marked with x was to be drawn on paper. The score was in terms of a certain normalized scale; time, fifteen minutes."

Data on 63 sighted male students from the Jarvenpaa Vocational Training Institute for Invalids (Finland) was presented in the text. Juurmaa, J., 1967, (pp. 32-33).

KNOTTS' AND MILES' "THE MAZE LEARNING ABILITY OF BLIND COMPARED WITH SIGHTED CHILDREN"

"A stylus maze and a high-relief maze of an identical multiple-T design were used. With 40 blind children, ranging from 14 to 20 years of age, were paired 40 normal children, carefully matched as to chronological and mental age and sex. Twenty pairs were given the stylus maze, and the other 20 pairs the high-relief maze. All subjects worked with eyes bandaged, and were given successive trials until the maze was learned. The blind made median scores indicating somewhat better success than the normal in number of trials, total errors, and total time for both mazes. They also showed greater variation. Intercorrelations of the scores for trials, error, and time were obtained, ranging from 0.88 to 0.98; and the correlations between mental age and maze learning were high. The high-relief maze was more easily learned than the stylus maze. The verbal method of learning appears most efficient and was used more by the blind." Knotts, J. R. and Miles, W. R., 1929. *Psychological Abstracts*, 1929/3003.

KLUVER'S "EIDETIC PHENOMENA"

"Studies have been made of perceptual, imaginal, etc. functions in adults in the light of facts previously arrived at by eidetic research on children; and the distinction between 'integrated' and 'non-integrated' types has been a central one. Correlations and relationships have been studied between eidetic imagery, on the one hand, and intelligence, art, education, AI and MI, Purkinje phenomenon and capillaroscopy. The reviewer criticizes group examinations in favor of individual ones." (Purkinje) Kluver, H., 1932. *Psychological Abstracts*, 1932/3463.

KOHS' "KOHS BLOCK-DESIGN TESTS"

The prototype for all subsequent block-design type tests utilizes 17 design cards. Geometrical patterns are presented in several colors without a grid. The Ss in the original study were 366 children and were asked to reproduce the design on the cards with the use of appropriately patterned and colored cubes. The test was developed as a measure of performance intelligence. It has had wider application as well as being included in batteries of intelligence tests. An imagery factor is presumed to be present since the grid is absent although the S is allowed continual observation of the stimulus card. Kohs, S. C., (1920).

KUELPE'S "UEBER DIE OBJECTIVIRUNG UND SUBJECTIVIRUNG VON SINNESEINDRUCKEN"

Subjects were seated in a dark room and the experimenter threw faint lights of various shapes, sizes, and colors onto the wall in front of them. Sometimes no actual stimulus was given after the usual ready signal, but the subject had to decide whether he had an image or a percept. Kuelpe found that the judgment of the subject was not determined by anything in the impression itself, but relied more on the subject's own attitude and attention. Kuelpe, O., (1902).

KUHLMAN'S "STUDY IN THE MENTAL IMAGERY AND MEMORY OF MEANINGLESS VISUAL FORMS"

The purposes were to determine the nature of the imagery in recall of a given material, and to determine the nature of memory errors and the causes that produce them.

Five to nine meaningless visual forms were presented once for ten minutes. Immediately afterwards, and again after a number of different intervals of from two to ninety days, the subject was requested to recall the forms, giving as detailed

an introspective account as possible, of the nature of the imagery, the process of recall and recognition, etc. He was also requested each time to draw the forms from memory as accurately as he could. The forms were in three classes:

1. the altered familiar geometrical form,

2. the continuous irregular curve, and

3. the several-part form of simple, straight, and curved lines.

Influential performance factors:

1. nature of the form;

2. frequency of repetition of recall and time elapsed.

The best recall performances were on form 1; next best performance on form 3; with poorest performance on form 2. Kuhlman, F., (1906).

"LEAVELL HAND-EYE COORDINATOR TESTS"

Ages 8-14; 1958; for determining need for training on the Leavell Hand-Eye Coordinator; individual; seven scores; hand-foot preference, visual imagery, (three scores), total; one form (three pages); manual for use of the coordinator (22 pages, four of which provide instructions for the test); no data on reliability; no norms; $3 per manual; $15 per box of 500 blanks; ten minutes. Ullin W. Leavell; Keystone View Co., Buros, O. K., 1965, (p. 1202).

"OHWAKI-KOHS TACTILE BLOCK DESIGN INTELLIGENCE TEST FOR THE BLIND"

A modification of the Kohs block design technique for use with blind subjects. Textures were added, colors modified, size enlarged, and some minor pattern changes were made. Ss were 276 totally blind students in a residential school in Japan. Satisfactory reliability and validity data was reported utilizing teacher-rating scales as correlates. Presumably imagery is a factor in the performance of this test by blind Ss, although no data is supplied. Ohwaki, Y., (undated).

PERKY'S "AN EXPERIMENTAL STUDY OF IMAGINATION"

Stimulus items were a tomato, a book, a banana, an orange, a leaf, and a lemon. Subjects were asked to fixate a white fixation mark placed on a ground glass window in the center of an open square and to hold this fixation while they "imagined" a colored object, for instance a tomato. A faint subthreshold, flickering image (to conform to the phenomena noticed with subjective images) was flashed onto the screen and was made stronger until the subject reported that he saw an image. The procedure and apparatus were quite complicated. Some subjects applied a context of pure imagery to their perception, confident that all they were doing was imaging. All subjects noted that the banana was upended and not as they had supposed it should look, yet there was no suspicion aroused. Perky, C. W., (1910).

RADAKER'S "IMAGERY AND ACADEMIC PERFORMANCE"

He constructed a battery of form tests:

1. The Visual Imagery Test was designed to measure images objectively.

2. The Memory for Designs Test was constructed by combining parts of the Memory-for-Design subtest in the Revised Stanford-Binet Scale, Forms L and M, and the Memory-for-Design Test by Graham and Kendall. It provided a measure of the subject's ability to remember abstract designs and diagrams.

3. The Memory for Objects Test depended on the subject's ability to remember objects and their placement, and measured ability to recall concrete objects.

4. The Memory for Words Test contained forty words which were low in frequency, unusual in pattern, and unfamiliar to the child, and measured imagery for words the subject did not know.

He concluded that imagery has a generalized effect that transfers in

degree from concrete to abstract, and that apparently training in imagery is effective for children at all levels of intelligence. Radaker, L. D., 1962.

RICE, FEINSTEIN AND SCHUSTERMAN'S "ECHO-DETECTION ABILITY OF THE BLIND: SIZE AND DISTANCE FACTORS"

"The ability of five blind Ss to detect metal discs placed in front of them by use of echoes was measured. S was instructed and trained to respond to the presence or absence of these targets after uttering any sound of his choice. Response thresholds were obtained for various size targets at distances ranging from 24 to 108 in. As distance increased, threshold target size increased. The mean auditory angle subtended by a target calculated to be at threshold was 4.63° with an SD of 0.21°. These data provide a basis for comparing performance using a vocal echo signal with performance using signal characteristics as independent variables." Rice, C. E., Feinstein, S. H. and Schusterman, R. J. (1965).

"ROBBINS SPEECH SOUND DISCRIMINATION AND VERBAL IMAGERY TYPE TESTS"

Ages 4-8, 8 and over; 1948-58; individual; one form; two levels; revised manual (1958, 46 pages) contains all tests; no data on reliability; no norms. Samuel D. Robbins and Rosa Seymour Robbins; Expression Co.

"The purpose of the Robbins tests is twofold: a. to determine just which types of speech sounds a child who manifests a phonetic speech defect of sensory origin is unable to differentiate; b. to help him see, hear, and feel the differences between the individual speech sounds which compose these groups." Buros, O. K., (1965), (p. 1202).

SCHAUB'S "INTENSITY OF AUDITORY AND VISUAL IMAGES"

The two sounds whose images were to be compared were produced by the same stimulus; there was no difference in pitch or timber, but only in intensity. Subjects were instructed to compare memory images rather than sensations.

A series of eight experiments were performed:

1. Two tones were sounded either louder, softer, or the same. The response was noted as to the subject's awareness as to difference in intensity.

2. Same procedure with distracting auditory or visual interference stimulus.

3. Same procedure with time interval between tones increased from 20 seconds to one minute.

4. Used "sound-pendulum" emitting "noticeable" and "just noticeable" differences in loudness.

5. Same as above with varying periods of recall of 30, 60, and 120 seconds.

6. Observations made on images of imagination instead of upon memory images.

7. Investigation of minimal and maximal limits of imaginal intensity. Both very loud and very soft sounds given on gravity phonometer as well as on sound-pendulum. After 30 seconds subject was asked to reproduce the sound in image.

8. To compare results in field of auditory imagery with those in other fields, a series of tests on brightnesses. Brightness-discrimination box used to let subject simultaneously see two brightnesses side by side. The subject recalled the experience in a memory image dictating his introspections to the E.

Results: Images possess the attribute of intensity, i.e., they are not always weaker than original sensation. With imaginal intensity the intensive attribute was believed to be one and the same whether it was that of sensation or of the image. The degrees of imaginal intensity corresponded with sensational intensity with the possible exception of loudness. Schaub, A. de V., (1911).

SCOTT'S "THE RETENTION AND RECOGNITION OF PATTERNS IN MAZE LEARNING"

"Human learners of cardboard *T* mazes retain the pattern over 24 hours, and although the subject does not recognize that he is subsequently relearning the same or a similar maze, the fact is given as supporting the doctrine that 'pattern' is retained. Recognition is largely a question of set. Verbal imagery was superior to motor imagery." Scott, T. C., 1930. *Psychological Abstracts*, 1931/155.

SCOTT'S "MINOR VARIATIONS IN MAZE PATTERNS: II. THE EFFECT UPON THE ACCURACY OF THE REPRODUCTIONS OF THE MAZE"

"Subjects were asked to reproduce five (four finger, one groove) Warden-type mazes. Of the 253 drawings, 112 were correct for turns, 127 were incorrect for turns but could be measured, and 14 were so incorrect they could not be measured. Ten of these 14 were drawings of the groove maze. The lengths of alleys were overestimated. The average estimation of all horizontal moves was greater than that of vertical moves." Scott, T. C., 1936. *Psychological Abstracts*, 1937/2670. (b).

SEASHORE MEASURES OF MUSICAL TALENTS, REVISED EDITION.

"Grades 4-6 and adults; 1919-60; six scores: pitch, loudness, rhythm, time, timbre, tonal memory; IBM; one form: Series A ('57, one 33 rpm record, essentially the same as 1939 revision except for record size and modification indirections); manual, second revision ('60, 10 pages); no adult norms; $12 per set of records, 50 IBM answer sheets, scoring key, and manual; $2.30 per 50 IBM answer sheets; 60¢ per set of manual and scoring key; postpaid; (60) minutes; Carl E. Seashore, Don Lewis, and Joseph G. Saetveit; Psychological Corporation." Buros, O. K., 1965, (p. 627).

SHORT'S "THE MEASUREMENT OF MENTAL IMAGES USING BRAIN WAVES AND RESPIRATION"

"One hundred fifty subjects were examined with a two-channel portable EEG machine, during the solution of six different mental tests. The first channel recorded electrical potentials from the posterior areas of the brain, and the second channel recorded breathing by means of a thermocouple. It appeared the subjects fell into two main categories of imagery, visual and verbal. The extreme alpha types, P (persistent), and M (minus) correlated with extreme types of imagery, and the R (responsive) type with 'moderate' imagery, though with a clearly recognizable predominance of visual or verbal images." Short, P. L., 1953. *Psychological Abstracts*, 1953/4097.

START'S AND RICHARDSON'S "IMAGERY AND MENTAL PRACTICE"

Scores on tests of vividness and autonomy of imagery were compared with scores on their experimental task. All subjects were given six daily five-minute periods of standardized mental practice of the skill, and on the seventh day were asked to perform the movement for the first time.

Vividness of imagery was found not to be a critical factor in the efficiency of mental practice of physical skills, although it was suggested that kinesthetic imagery was a minor factor in success of the criterion skill. When the performance scores of subjects with vivid autonomous imagery were compared with those of subjects with all other imagery combinations, it was found that vivid imagery which is not under the control of the individual tends to be associated with low performance scores. Start, K. B. and Richardson, A., (1964).

SUINN AND DAUTERMAN--"MANUAL FOR THE STANFORD-KOHS BLOCK DESIGN TEST FOR THE BLIND"

An adaptation of the Kohs Block Design technique for use with the blind and partially sighted. The materials, procedures and tasks were somewhat different from those used by Ohwaki. The test was standardized on 428 legally blind American adult Ss. Significant reliability was reported between this test and Ohwaki's version. Test-retest reliability was 0.86 for all Ss (N = 50).

Validity was established by significant correlations with other standardized measures of intelligence and education achievement. Since there was found a high correlation with the Ohwaki test, it is assumed that this test also will yield a high correlation with tests of imagery ability. Suinn, R. M. and Dauterman, W. L., (1966). (a)

SUINN AND DAUTERMAN--"STANFORD-OHWAKI-KOHS BLOCK DESIGN TEST FOR THE BLIND"

Utilized the Ohwaki test apparatus and procedures to standardize the test on an adult American population as a performance test of intelligence. Using 200 subjects statistically significant reliability and validity data was reported. Imagery ability was assumed to be a prerequisite for the performance of this test by blind subjects, although data is not reported in the test manual. Elsewhere, in Dauterman, W. L. and Suinn, R. M., 1966, report a correlation of 0.70 using this test and the experimental form of the Stanford Multi-Modality Imagery Test (N = 159). Suinn, R. M. and Dauterman, W. L., (1966). (b)

SUTCLIFFE'S "ADAPTATION OF KOHS BLOCK-DESIGN TESTS"

A series of blocks were prepared using four colors and four geometrical figures (quite unlike Kohs' original apparatus). Subjects were allowed to familiarize themselves with the material and asked to reconstruct stimulus patterns under various experimental conditions. Vividness of image, recall of pattern, and correct perception of display were important experimental procedures. The data were used to differentiate among those subjects objectively demonstrating more or less vividness of imagery. They were also asked to rate themselves as to vividness of imagery on a seven-point scale, a subjective response. Sutcliffe, J. P., (1963).

SUTCLIFFE'S "MATCHING SIZE, FOCUS, AND BRIGHTNESS OF STIMULI WITH IMAGES"

Utilizing a complicated system for the projection and measurement of a monochromatic patch on a ground glass screen, subjects were instructed, "In this experiment I will present a figure on the screen in front of you, for you to inspect. Then, after I have taken the figure away, I will ask you to get a mental image of it. Then I will ask you to adjust the apparatus controls to reproduce your mental image on the screen with respect to size, clarity, and brightness (p. 8)." Several experimental variables were introduced by interposing stimuli of different characteristics of size, clarity and brightness between the initial stimulus and the subjects' response. Performance with the use of the apparatus was correlated with their responses to the "Short Form of the Betts Test for Vividness of Imagery" administered before and after the "matching test."

"The evidence suggests that subjects with vivid imagery of objects and events revivify those objects and events with comparative accuracy, while the recollections of subjects with poor imagery may or may not be accurate. (Summary of Progress)." Sutcliffe, J. P., (1964).

SUTCLIFFE'S "PROCESS SIMILARITY OF IMAGING AND PERCEIVING"

Utilizing an elaborate apparatus and procedure, the subject was asked to adjust a line on a disc with regard to verticality, after having been given various sets of biased and nonbiased instructions interposed with time intervals and distracting activities.

"Within a particular context this experiment *has* confirmed the hypotheses that imaging is distinct from perceiving when adequate control is exercised over expectancy of the outcome of stimulation," (p. 63). Sutcliffe, J. P., (1964).

WHIPPLE'S "STUDY OF THE MEMORY IMAGE AND THE PROCESS OF JUDGMENT IN THE DISCRIMINATION OF CLANGS AND TONES"

The aim of this test was chiefly to determine how much influence the memory image of a tone has upon its discrimination from another tone. Reed tones as well as bottle tones were used. Three of the six observers were musical, three unmusical. The reed tones used as standard tones were of 612, 724, 832, and 984 vibrations, the variations about eight vibrations. Observations were: Increase of the time interval caused a general decrease in the total number of right cases. The memory image was often found by introspection to be exceedingly weak or lost when the judgment was certain and correct. Within the octave emphasized there was no observable dependence on pitch. The unmusical observers often judged "different" without deciding higher or lower. The musical observers almost never confused the direction of a difference. Speed, certainty, and correctness of judgment were closely correlated. Whipple, G. M., (1901).

WORCHEL'S "EXPERIMENT A: TACTUAL FORM PERCEPTION"

"In Part 1 small blocks of simple geometrical shapes are manipulated in one hand; in Part 2 larger blocks are used and both hands are permitted to explore the object. The methods of reproduction (drawing) and verbal report (description) are employed. In Part 3 the method of recognition is used in selecting the stimulus block from four choice blocks," (p. 4).

Both adventitiously- and congenitally-blind children and a control group of matched sighted children were all blindfolded and administered the three experimental tests.

"The results show that:

"1. The sighted were significantly better than the blind in the reproduction and description of each of the blocks in Tests 1 and 2.

"2. The accidentally blinded gave significantly better reproductions and descriptions than the congenitally blinded in Tests 1 and 2.

"3. With the method of recognition, however, there was no significant difference between the blind and the sighted, and between the accidentally and the congenitally blinded. The scores for all the Ss indicated almost perfect tactual form perception.

"4. There was significant and high correlation between age at onset of blindness and the scores in Tests 1 and 2 for both reproduction and verbal report.

"5. There was no significant relationship between the chronological age of the blind and the scores on Tests 1 and 2.

"6. There was a slight but insignificant difference in favor of the male over the female blind with the method of reproduction in Parts 1 and 2, but no sex difference with the method of verbal report.

"7. The introspective reports and the analysis of the results of age at blinding indicated that superior performance in tactual form reproduction and description was probably due to the translation of successive tactile impressions into a visual image of the total form. Visual imagery, however, did not result in superior performance in the recognition of tactual form," (p. 14). Worchel, P., (1951).

WORCHEL'S "EXPERIMENT B: TACTUAL SPACE RELATIONS"

The apparatus consisted of two sets of geometrically-shaped blocks: the stimulus blocks consisted of two parts of each of seven shapes; the seven response blocks corresponded to the stimulus blocks when correctly assembled.

Subjects were all children, all blindfolded, some congenitally blind,

some adventitiously blind, and some fully sighted matched controls.

"The results show that:

"1. The sighted made significantly fewer errors than the blind.

"2. The accidentally blinded were significantly superior to the congenitally blinded in the imaginal manipulation of space relations.

"3. There is a definite relationship between age at blinding and accuracy on the space-relations test.

"4. There is a significant partial correlation between the chronological ages of the blind and error scores on the space relations test when the effect of age at blinding is held constant.

"5. There is no significant sex difference on the space relations test.

"6. Split-half reliability of the space relations test indicates that the scores are a fairly reliable index of the ability of the blind Ss at the time of the administration of the test.

"7. The easiest forms for the blind and the sighted to recognize from the tactual perceptions of the individual parts were the ellipse and circle. The most difficult form to recognize was the semicircle when the stimulus forms were the two quarter-circles.

"8. The few introspective reports that were given indicate that visual imagery in the sighted and in the accidentally blinded occurred during the process of handling the choice blocks. The Ss tried to imagine whether the individual parts previously experienced could make up a particular block.

"9. The use of visual imagery is of definite aid to the sighted and to the accidentally blinded in imaginally manipulating tactual perceptions," (pp. 19-20). Worchel, P., (1951).

WORCHEL'S "EXPERIMENT C: SPACE ORIENTATION"

The apparatus used was eight isosceles triangles drawn on a large concreted area. The procedures:

> "Task 1 consisted in leading S along the two sides of the triangle. He was to return without guidance, via the hypotenuse path, to the starting point. In Task 2 S was led along the hypotenuse and he was to return to the starting point along the two paths which formed the legs of the triangle."

Subjects were matched groups of blind and sighted school children, all of whom were blindfolded.

"The results showed that:

"1. The sighted were significantly better than the blind, that is, they returned closer to the starting position.

"2. There was no difference between the congenitally blinded and the accidentally blinded on the space orientation tests.

"3. There was no significant relationship between age at blinding and space orientation scores.

"4. There was no significant relationship between the chronological ages of the blind and the space orientation scores.

"5. There was no significant difference between the space orientation scores of the male and the female Ss.

"6. The error in missing the starting position increased for both the blind and sighted Ss as the hypotenuse distance increased.

"7. The few introspective reports given by the Ss indicated that both the blind and the sighted used *time* in estimating the distance from the starting position; but the sighted used visual imagery in determining

the direction of the starting position and the returning path.

"These results lead to the conclusion that in the absence of auditory cues, the blind rely primarily on *time* for distance estimation. Kinesthetic cues without the aid of visual imagery resulted in poor directional orientation. The sighted Ss, in the absence of visual cues, use both time and visual imagery for estimating distance and direction," (p. 26). Worchel, P., (1951).

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SOCIAL AND PSYCHOLOGICAL ASPECTS OF BLINDNESS: A SAMPLING OF THE LITERATURE

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The subject of the sociopsychological consequences of blindness is vast. However, the several aspects of the area do form an integral whole. It may be helpful to have an overview of the topic stressing this *emergent property* of the literature. In what follows I have attempted to do this and to provide selected bibliographic references as well.

In discussing socialization of congenitally-blind children Scott (1969) underlines the difficulties produced by lack of vision in role learning, imitation, body-image, and self-concept development and communication. The picture is somewhat overdrawn, as awareness of others and coping with the environment is often achieved to a much greater degree than Scott seems to suggest. However, the problem areas he indicates do indeed exist, and adequate development depends on timely acquisition of substitutes for vision in coping with them (Fraiberg and Freedman, 1964; Fraiberg et al., 1969).

One interpretation of this process is found in the discussion of *compensation* by Zemtsova (1969), again in a somewhat overstated form. The intensified use of the other senses, particularly hearing and touch, and the formation of patterns of reflexes and habits on that basis, is reflected in two peculiarities: of the organization of the orienting reflex, and the electrical activity of the brain in the blind (Novikova, 1970). This view is supported by evidence of the great difficulty of reverting to the use of vision after prolonged blindness (Valvo, 1971).

With some notable exceptions (Norris, Spaulding and Brodie, 1957; Imamura, 1965), our knowledge of the early psychosocial development of blind children is derived from clinical observations and reports and interpretations of case histories, usually by psychoanalytically oriented authors. One such study (Omwake and Solnit, 1961) gives a startling glimpse of the degree of awareness which can exist in an intelligent blind child functioning at a profoundly retarded level. It also indicates the intense anger and frustration which the limitations imposed by lack of vision can produce even in the very young congenitally blind. This is confirmed by Burlingham (1965), who points to frustration as one of the causes of the apparent passivity of many blind children. In another paper Burlingham (1961) discussed the avoidance of the subject of blindness and vision by sighted adults, and their intense emotional reaction when the subject is broached by the blind child. The psychological effects of this in many ways parallel those of emotionally charged avoidance of sexual topics.

Owing to the distinctive characteristics of different sense modalities, the use of touch and hearing in place of vision has certain psychological consequences. In the early months of life there is a transition from a passive, receptive oral stage to a more active one. The role of the hand changes at this point: it has been a grasping extension of the mouth; it now becomes autonomous, manipulative and exploratory in nature (Sandler, 1963). Vision plays a guiding and distancing (neutralizing) role in this transition. The blind infant, therefore, has an added difficulty in achieving autonomy of the hand, but at the same time establishing this perceptual and cognitive function of the hand is crucial for his development (Fraiberg, 1964). The tactile sense can only provide perception of objects

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within reach, and the auditory sense does not provide continuity--sounds being usually intermittent. As a result the concept of object permanence is much harder to attain for the congenitally blind than for the sighted. This can create both cognitive and emotional problems (Fraiberg, Smith and Adelson, 1969; Fraiberg, 1968), for instance a more intense separation anxiety in response to absence of the mother, occurring up to a later age than in the sighted.

In the mother-child relationship another problem-generating factor is the mother's reactions to the child's blindness: depression, rejection, over-protection (Sommers, 1944; Lairy, 1969). Moreover, these are attitudes shared by other members of the family to a greater or lesser extent.

When blindness occurs later in life--once cognitive development, independence and the socialization of the individual are accomplished facts--the difficulties it creates are less fundamental. The problem is then to learn new ways to carry on already established activities, and to accept the curtailment of some. However, the differences between adequately-functioning congenitally- and adventitiously-blind adults are not as great as this might suggest. They have reached a similar condition via different paths. Where the magnitude of the handicapping effect of congenital or early blindness does show is in the number of those who never reach that level of functioning. "Mental retardation" is the most frequently encountered additional impairment in blind children (Graham, 1968). We know that this is very often pseudo-retardation, which could have been prevented and can even be reversed (Hallenbeck, 1954; Elonen and Zwarensteyn, 1964; Elonen, Polzien and Zwarensteyn, 1967); but that opportunity has not been realized.

The sequence of reaction to the onset of blindness--initial shock, mourning period--has been described by a number of authors, and usually interpreted from a psychoanalytic point of view (Cholden, 1958; Blank, 1957). An alternative, Pavlovian, interpretation of at least the *mourning period* is suggested by data on reaction to restoration of vision: the change-over from an established pattern of habits in one sensory modality to new habit patterns in another is accompanied by deep depression, even in this case of "gain" rather than "loss" (Valvo, 1971). The process of depression and recovery has been termed a dying as a sighted person and rebirth as a blind one (Cholden, 1958; Carroll, 1961). However, the discontinuity of personality which this implies has not been verified. Shontz (1970) upon reviewing recent research on disability and personality concludes that "basic personality structure appears to be remarkably stable. . . . Such disorganization as occurs is generally transient," (Shontz, 1970, p. 62). On the contrary, preexisting personality factors influence the course of adjustment and rehabilitation (Hallenbeck, 1967). The onset of blindness may in fact bring personal problems to a head (Lokshin, 1957). At times, on the contrary, blindness may also serve to mask psychological maladjustment (Cutsforth, 1951). The eventual status of the blinded individual is also determined in large measure by the attitudes and expectations of his milieu (Lukoff and Whiteman, 1970), and his economic situation and opportunities for rehabilitation services and training (Graham et al., 1968).

Two recent books take a systematic and documented look at the life of blind adults. Kim (1970) examines the correlates of identification with the blind as a group vs. integration into the sighted community. Josephson (1968) delineates the social and economic conditions of the blind and relates them to their personal needs and leisure activities.

In the realm of attitudes research Siller (Siller et al., 1967) has developed the Disability Factor Scales, including a seven-factor scale of attitudes toward blindness. The factors which have emerged through the development of the DFS are relatively independent dimensions of attitude, resulting in an instrument of unprecedented sensitivity and a conceptual framework for further research. Another project of considerable scope and interest is Jordan's cross-cultural study of

attitudes toward disability (Jordan, 1968). Blindness was not included, but the project is of interest from a methodological point of view for the use of an adapted version of Guttman's facet design (Jordan, 1970). The clusters of responses which comprise the factors in Siller's Scales seem to indicate a relationship to personality factors. The attitudes involved might consequently be expected to be stable and hard to alter. A recent study from the mental health field (Rosen, 1970) seems to support this; the author concluded that public education is relatively futile and effort should preferably be directed towards improved services.

The largest, and most neglected group among the blind are the aged. Scott and Kalish have discussed this problem and its sources within our culture in general and the field of blindness and rehabilitation in particular (Scott, 1968). The organizational sources of this neglect were also analyzed in a paper on client selection by agencies (Scott, 1967). The position of the aged blind is also given considerable attention in Josephson's book *The Social Life of Blind People* (1968), already mentioned. It is generally recognized that, in the case of the aged, blindness is usually only one of a number of severe problems. Lokshin (1957), drawing on casework experience, illustrates the interplay of blindness as such and other problems of the aged. Since the Research Conference on Geriatric Blindness in 1967 (Clark, 1968) increasing effort has been made to deal with the problems of the aged blind. These problems and those of the multiply impaired and aged in general, however, are closely linked to the prevailing value system. The magnitude of the task is suggested by Dr. Alvin I. Goldfarb's paper at a conference on extension of human lifespan held at the Center for the Study of Democratic Institutions, Santa Barbara. Dr. Goldfarb warned that, under present conditions, the benefits derived from a lengthened life expectancy may be outweighed by its deleterious psychosocial consequences (reported in *Geriatric Focus*, 9(5):5-6, June-July, 1970).

Taking a broad cross-cultural and historical view, Graham and Clark (in preparation) have analyzed the treatment of the blind in various societies, past and present. The determining factors that emerge are in part economic, both the level of affluence and the economic structure of the given society, and in part psychological; the fear, rejection or awe evoked by those deviant from the normal being modified by the values of a society and other specific circumstances. It may well be salutary to maintain an awareness of these basic influences when dealing with more specific problems of the blind in a sighted society.

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KINESTHETIC PERCEPTION IN EARLY BLIND ADULTS*

Sondra Lindley

INTRODUCTION

To the sighted person who depends so fully on vision to organize and direct his life's activities, the ability of the blind person to function without sight often seems incomprehensible. The situation for the congenitally-blind person, who must understand the world without benefit of visual images or memories, seems especially problematic. Particularly puzzling is the question of how spatial concepts develop without vision, the sense *par excellence* for the apprehension of space. The problem applies not only to space outside the body, but to the spatial organization of the blind person's body which he must in some way understand as an object extended in space with interrelated and integrated parts. Rehabilitation techniques in mobility, activities of daily living, and work training rest on assumptions about how the blind person perceives his body. The present paper examines some assumptions which are often implicit in rehabilitation procedures, reviews research relevant to the assumptions, and draws conclusions both from previous work and from the present study of kinesthetic perception in early blind adults.

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PROBLEM

Research verifies the clinical impression that development and exploitation of motor capacities are sometimes inhibited in blind people (Buell, 1950; Norris, Spaulding, and Brodie, 1957; Siegel, 1966). The *optification hypothesis*, a convenient expression used by Juurmaa and Suonio (1969), has been advanced as a possible explanation for the phenomenon. The hypothesis, which is often implicit in rehabilitation techniques used with the blind, suggests that perception is more accurate when somesthetic sensations are transposed into visual images. The blind person is handicapped in motor function because he cannot employ the superior integrative function of vision to interpret body sensations and guide body movements. The present investigation of kinesthetic perception in sighted and early blind adults tests the adequacy of the optification hypothesis in explaining body perception.

The problem of the relationship between vision and somesthetic perception arises logically from propositions of Head and Holmes (1912) regarding the mechanism of body perception. The writers, whose ideas enjoy continuing acceptance today, concluded from observations of patients with neurological diseases that body sensations, rather than being experienced directly, are mediated by a central organizing mechanism termed the *body schema*. The body schema, an unconscious spatial model of the body constructed and altered by sensory input, forms a standard against which changes in body perception are measured before they become conscious.

The somewhat rudimentary formulations of Head and Holmes did not satisfactorily resolve the question of the relationship between vision and somesthetic perception in the development of the body schema. Disagreements about the matter among subsequent writers reflect uncertainty about how well the concept of the body's spatial attributes[1] develops in the absence of vision. In the extreme view of Von Senden (1960) where space as a concept does not exist without vision, the congenitally-blind person cannot cognize his body as a whole figured object in space. A more moderate view suggests that somesthetic sensations give less exact information than vision about space (Cratty and Sams, 1968; Wilson and Halverson, 1947). More recently, researchers have contended the absence of visual imagery may not determine any essential features of an individual's spatial conception (Duran and Tufinkjian, 1970). One blind author describes how he *conjures up* spatial images that have no visual component (Duran, 1969), and another researcher with the blind reports from factor analytic studies a spatial factor independent of sensory modality (Juurmaa, 1967).

Two major hypotheses have been advanced to explain the relationship between vision and body perception. The optification hypothesis predicts that perception is more accurate when somesthetic sensations can be transposed into visual images (Duncan, 1934; Koch and Ufkess, 1926; Worchel, 1951). The *sensory compensation hypothesis* predicts that the congenitally-blind person will develop somesthetic hypersensitivity in the absence of vision (Critchely, 1950; Rice, 1969).

RESEARCH FINDINGS

A variety of methods have been employed to investigate the role of vision in organizing body sensations. The general approach involves comparison of the performance of blind and sighted subjects on one of the following tasks: maze learning, form perception, discrimination of spatial attributes, or proprioception. The nature of the tasks permits the construction of inferences about spatial abilities in the presence and absence of visual imagery.

Maze learning studies have yielded inconsistent results (Table 1). On three maze learning tasks, there were no differences between sighted and blind subjects (Berg and Worchel, 1956; Bottrell, 1968; Duncan, 1934), on two tasks the sighted subjects were superior (Berg and Worchel, 1956; Koch and Ufkess, 1926), and on two, the blind were superior (Knotts and Miles, 1929).

There are problems in addition to the inconsistent results in interpreting the maze learning studies. Observations that the more successful blind subjects have a history of useful vision support the optification hypothesis (Duncan, 1934; Knotts and Miles, 1929; Koch and Ufkess, 1926). However, visualization appears to be but one of several factors involved in maze learning. Evidence indicates that performance correlates with intelligence (Berg and Worchel, 1956; Knotts and Miles, 1929; Koch and Ufkess, 1926) and with ability to verbalize (Berg and Worchel, 1956). Deaf subjects cannot learn mazes as readily as sighted or blind subjects.

In studies of form perception (Table 2), Drever (1955) and Worchel (1951) have gathered impressive evidence for the role of visualization in organizing tactile-kinesthetic sensations. However, Juurmaa and Suonio (1969) have presented convincing argument that the results in the studies mentioned above depend on the optic familiarity of the objects involved, not on the ability of the subject to visualize. The latter authors found that when the forms of the objects were optically unfamiliar, the advantage of sighted subjects over blind disappeared. The authors suggest that the findings in Drever's and Worchel's studies depend on association rather than on ability to visualize. The findings of Witkin *et al.* (1968) can also be explained on the basis of optic familiarity.

In studies comparing the perception of spatial attributes and proprioceptive stimulation, there is again no evidence for the optification hypothesis (Tables 3 and 4).

TABLE 1

Studies Comparing Maze Learning in Blind and Sighted Subjects

Author	Subjects: Visual History	Subjects: No.	Subjects: Age	Task	Results	Comments
Berg and Worchel (1956)	Early blind Late blind Sighted (Deaf)	17 11 28	7-20 yrs 7-20 yrs 7-20 yrs	U finger maze	Bl = Sighted EB = LB Bl & Sighted superior to deaf	Verbalization involved in task Intelligence not correlate with performance
				Multiple X finger maze	Bl inferior to sighted EB inferior to LB Deaf inferior to BL & Sighted	
Bottrell (1968)	Mixed? blind Mixed? blind Sighted	21 12 33	Mean 12.6 yrs 34.1 yrs 20.7 yrs	U finger maze	Bl = Sighted	
Duncan (1934)	Mixed blind Sighted	30 30	Median 17.5 yrs 17.6 yrs	Square finger maze	Bl = Sighted	Verbalization involved in task Performance correlates with visual history
Knotts and Miles (1929)	Mixed blind Sighted	20 20	13-22 yrs 13-22 yrs	T stylus maze	Bl somewhat better than sighted	Verbalization involved in task
				T finger maze	Bl somewhat better than sighted	Intelligence correlates with performance Performance correlates with visual history
Koch and Ufkess (1926)	Mixed blind Sighted	19 20	14-26 yrs 14-32 yrs	Square stylus maze	Sighted tend to be better than blind but difference not significant	Verbalization involved in task Intelligence correlates with performance Performance correlates with visual history

TABLE 2

Studies Comparing Perception of Form by Blind and Sighted Subjects

Author	Subjects: Visual History	No.	Age	Perceptual Modality	Task	Results
Drever (1955)	Early Blind Late Blind Sighted	19 18 37	Mean 14.11 yrs 14.11 yrs 15.3 yrs	Tactile kinesthetic	Form recognition	Sighted superior to blind and to early blind Late blind superior to early blind
					Form reproduction	Blind and late blind superior to sighted Late blind superior to early blind Early blind = Sighted
					Form classification (pegboard)	Blind classify by shape Sighted classify by counting
Juurmaa and Suonio (1969)	Early blind Late blind Sighted	20 20 20	Mean 20.3 yrs 26.3 yrs 22.9 yrs	Tactile kinesthetic	Form description, reproduction, & recognition: three degrees of optic familiarity	Effect of familiarity significant: Familiar Sighted superior to blind Unfamiliar Sighted = Bl Groups x experiment interaction significant
					Tactual space relations	EB = LB = Sighted
Worchel (1951)	Early blind Late blind Sighted	23 10 33	8-21 yrs 8-21 yrs 8-21 yrs	Tactile kinesthetic	Form description	Sighted superior to blind Late blind superior to early blind
					Form reproduction	Sighted superior to blind Late blind superior to early blind
					Form recognition	Sighted = Late blind = early blind
					Space relations	Sighted superior to blind Late blind superior to early blind
					Space orientation	Sighted superior to blind Early blind = late blind

TABLE 2 (cont'd)

Author	Subjects: Visual History	No.	Age	Perceptual Modality	Task	Results
Witkin *et al.* (1968)	Early blind Sighted	25 28	Mean 14.6 yrs 14.11 yrs	Tactile kinesthetic	Embedded figures	Sighted superior to blind
					Block design	Sighted = Blind
					Match sticks	Sighted = Blind
					Clay modelling	Sighted superior to blind

TABLE 3

Studies Comparing Perception of Spatial Attributes by Blind and Sighted Subjects

Author	Subjects: Visual History	No.	Age (yrs)	Perceptual Modality	Task	Results
Bartley, Clifford, and Calvin (1955)	Early blind Sighted	10 10	8-19 1/2 8-10 1/2	Tactile kinesthetic	Size discrimination at varying distances from the body	Distance significant effect on performance of sighted but not blind
Crewdson and Zangwill (1939-40)	Early? blind Sighted	1 3	Adult? Adult?	Tactile kinesthetic	Perception of curvature	Threshold: Bl = Sighted Long arm Bl = 1 Sighted Bl inferior to 2 sighted Short arm Bl = 2 Sighted Bl superior to 1 sighted
Hunter (1954)	Mixed blind Sighted	20 20	12-18 12-18	Tactile kinesthetic	Perception of curvature	Blind superior to sighted

TABLE 4

Studies Comparing Perception of Proprioceptive Stimulation by Blind and Sighted Subjects

Author	Subjects: Visual History	Subjects: No.	Subjects: Age	Perceptual Modality	Task	Results
Bender, Green, and Fink (1954)	Early blind Sighted	42 40	3-14 yrs 3-6 yrs	Tactual	Perception of simultaneous tactile stimulation	Sighted = Bl
Bitterman and Worchel (1953)	Early blind Sighted	22 22	9-24 yrs 9-24 yrs	Vestibular	Indicate true vertical and horizontal	
					Subject upright	Mean deviation Sighted = Bl Lateral discrepancy Sighted = Bl
					Subject tilted	Mean deviation Sighted = Bl Lateral discrepancy Bl superior to sighted
Renshaw, Wherry, and Newlin (1930)	Early blind Early blind Sighted Sighted	4 7 7 4	20-24 yrs 8-14 yrs 18-65 yrs 8-11 yrs	Tactual	Localization of point stimulated	Early blind adults superior to early blind children and to sighted adults Sighted children superior to sighted adults and to early blind children
Rice (1969)	Early blind Late blind Sighted	1 2 2	17-30 yrs 17-30 yrs 17-30 yrs	Tactual	Localization of point stimulated	Early blind superior to late blind and to sighted
Slinger and Horsley (1906)	Early blind	22	Adolescents & young adults	Kinesthetic	Localize arm position	Blind superior to sighted
	Sighted	25	Adults?			

With one exception in the Crewdson and Zangwill study (1939-40), the performance of blind subjects is equal to or better than performance of sighted subjects.

The results of the study of tactual localization by Renshaw, Wherry, and Newlin (1930) draw attention to an important consideration in interpreting data from many studies relevant to the optification hypothesis. The above authors present empirical evidence that comparative function of sighted and blind subjects on perceptual tasks varies with the age of the subjects. Other authors have corroborated the findings (Warren and Pick, 1970). The critical age for the stabilization of the development of perceptual function falls in the range of from thirteen to fifteen years (Wapner and Werner, 1965). Results from studies in which children or samples of mixed ages are used as subjects are difficult to interpret.

Similarly, results from studies in which visual history is not controlled are difficult to interpret. In some studies discussed here, results from early and late blind subjects are mixed together and in other studies, visual history is not reported. The importance of controlling visual history in testing the optification hypothesis is obvious.

As tests of the optification hypothesis, the results of most studies discussed here should be qualified by either sample or task characteristics. Performance in maze-learning studies and studies of form perception depends on variables in addition to visualization. All but three of the studies of perception of spatial attributes and proprioception are limited by uncontrolled effects of the age or visual history of the subjects.

Three studies which fulfill requirements for testing the optification hypothesis indicate the hypothesis is not tenable (Table 5). Consistently superior performance of early blind adults on tactual and kinesthetic localization suggests that vision does not play a role in organizing somesthetic sensations. The concept of the body's spatial attributes does not seem to depend on vision. The three studies might be interpreted as evidence for the sensory compensation hypothesis. However, two of the studies must be qualified by small sample size and two by the lack of statistical treatment of the data. It should also be noted that Rice's early-blind subject was especially selected because of his previously noted perceptual sensitivity.

HYPOTHESES

Attention to statistics and sample size in the present study represents an effort to complement earlier work by strengthening the technical basis for testing the optification hypothesis. Three hypotheses were tested in the study. According to the optification hypothesis, early-blind adults were expected to be less accurate than sighted adults on a test of kinesthetic perception (perception of arm movement and position). Two subsidiary hypotheses important in rehabilitation were tested simultaneously. It was predicted that altering input by adding a constant weight would improve accuracy of performance. It was also predicted that performance would not improve with repetition.

SAMPLE

The blind sample was selected to provide data which would form a basis for making inferences about the role of vision in organizing body perception. Blind subjects were selected to control visual history, age, and other characteristics which might correlate with performance.

A group of twenty early blind subjects,[2] ten men and ten women, were matched by sex and age to twenty sighted subjects. Mean age of the blind subjects was 26.9, of the sighted subjects, 26.1 with a range of 16 to 45 years. Blind subjects with known central nervous system dysfunction, psychiatric disorder, or mental retardation were excluded from the study as such characteristics might correlate with performance.

TABLE 5

Studies Testing the Optification Hypothesis

Author	Subjects: Visual History	No.	Age	Perceptual Modality	Task	Results
Renshaw, Wherry, and Newlin (1930)	Early blind Sighted	4 7	20-24 yrs 18-65 yrs	Tactual	Localization of point stimulated	Blind superior to sighted
Rice (1969)	Early blind Late blind Sighted	1 2 2	17-30 yrs 17-30 yrs 17-30 yrs	Tactual	Localization of point stimulated	Early blind superior to late blind and to sighted
Slinger and Horsley (1906)	Early blind Sighted	22 25	Adolescents & young adults Adults?	Kinesthetic	Localize arm position	Blind superior to sighted

METHOD

The experimental procedure was adapted from Ayres' test of kinesthetic perception (1966). Seated at a table, the subject repeated arm movements introduced by the experimenter. The method, which does not depend on verbal comprehension of spatial attributes, is particularly appropriate with blind subjects whose concepts of movement instructions used in studies with sighted such as "twice as long as" or "ninety degree angle," may be quite different from the concepts of sighted subjects.

The series of forty movement trajectories, which were the same for all subjects, was drawn on a sheet of paper 41 cm x 51 cm (16 x 20 ins.). Variance in performance which might be caused by length and directional characteristics of the trajectories was randomized by drawing the trajectories in an 80 x 100 matrix according to pairs of random numbers (Attneave and Arnoult, 1956).

The subject held a pencil mounted in a plastic bar, using the point of the pencil to record his response. For the weighted trials, the plastic bar was filled with thirteen ounces of lead shot.

Each response was scored twice, once for the actual magnitude of the error in locating the target position (position score) and once for the distance moved relative to the length of the target trajectory (movement score).

Since 80 trials were administered to each subject, 40 weighted and 40 unweighted, each of the trajectories appeared twice in an experimental session. The order of presentation of the trajectories was random for each subject with the same random order occurring on the weighted and the unweighted trials for a given subject.

The subjects were randomly assigned initial experimental condition and initial arm used with equal numbers of subjects beginning with weighted and unweighted trials and equal numbers beginning with preferred and nonpreferred arm. Subjects alternated arms every ten trials.

The split-half reliabilities of movement scores and position scores of each group on weighted trials and unweighted trials ranged from 0.728 to 0.929 (Table 6).

TABLE 6

Split-half Reliabilities of Position and Movement Scores for Sighted and Blind Subjects on Weighted and Unweighted Trials

Group	Split-Half Reliabilities: Position Scores		Movement Scores	
Sighted				
Weighted Trials	0.572	0.728[a]	0.731	0.845[a]
Unweighted Trials	0.721	0.838[a]	0.679	0.809[a]
Blind				
Weighted Trials	0.861	0.925[a]	0.867	0.929[a]
Unweighted Trials	0.692	0.818[a]	0.842	0.914[a]

[a]Corrected with Spearman-Brown formula.

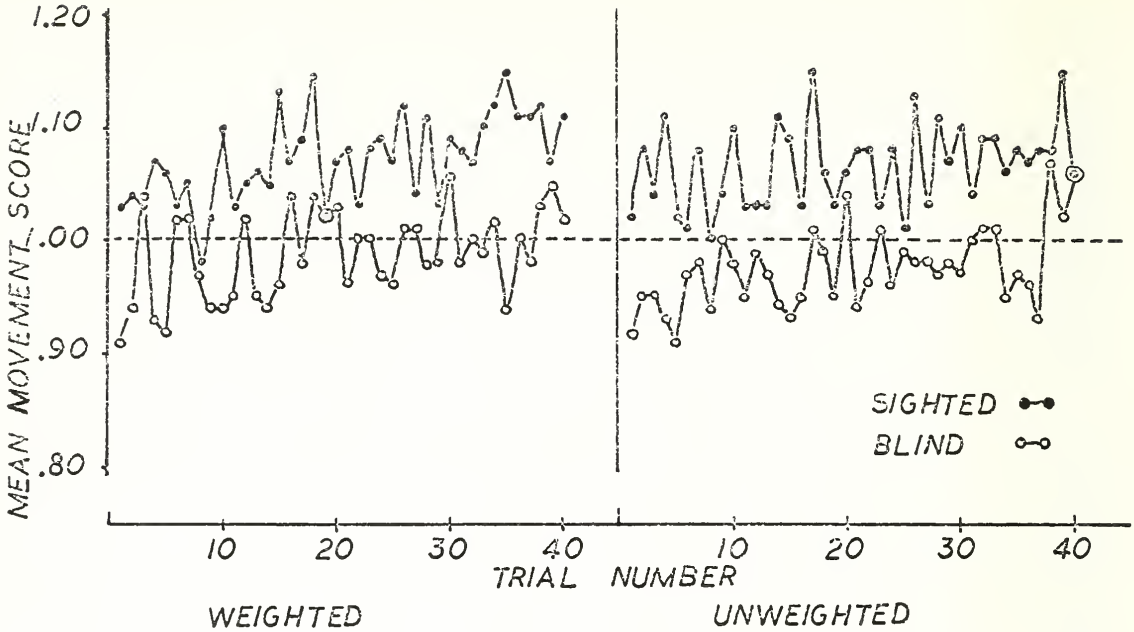

Figure 1. Influence of Visual Condition: Mean Movement Scores of Sighted and Blind Subjects on Trials One to Forty on Weighted and Unweighted Trials.

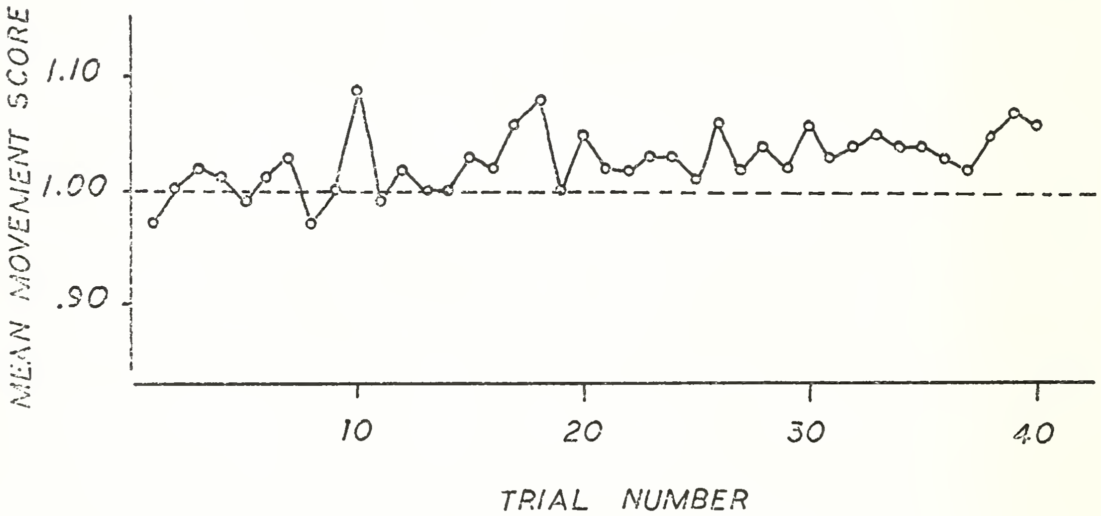

Figure 2. Influence of Practice: Mean Movement Scores of Sighted and Blind Subjects Combined on Trials One to Forty with Weighted and Unweighted Trials Combined.

RESULTS

The analysis of the movement scores showed that the early blind subjects were significantly more accurate than the sighted subjects in reproducing movement length (Figure 1). The blind subjects characteristically made shorter movements which more closely approximated the perfect score of one. On the same movement scores, there was an unexpected significant loss of accuracy from trial 1 to trial 40 when groups and experimental conditions were combined (Figure 2). The analysis of variance table for the movement scores appears in Table 7 and the means and standard deviations in Table 8.[5]

There were no significant differences on the position scores for any of the effects studied (Table 9). Table 10 gives the means and standard deviations of the position scores for the sighted and the blind groups.

DISCUSSION

Contrary to predictions of the optification hypothesis, early-blind and sighted adults in the present study were equally accurate in reproducing arm position and early-blind subjects were better than sighted subjects in reproducing arm movement. The findings, which concur with results of three similarly designed studies (Renshaw, Wherry, and Newlin, 1930; Rice, 1969; Slinger and Horsley, 1906), support the inference that visual imagery does not play a role in the construction of the spatial image of the body.

The superior performance of the blind subjects on arm movement suggests several interpretations. At first glance, the findings seem to provide support for the sensory compensation hypothesis which predicts that somesthetic hypersensitivity will develop in the absence of vision. However, the explanation is unsatisfactory as it does not at the same time account for the observed similarity in performance of sighted and blind subjects on a second parameter of kinesthetic perception, reproducing arm position.

Two other possible explanations suffer the same defect. The *theory of optic dominance* (Renshaw, Wherry, and Newlin, 1931) suggests that poorer performance of sighted subjects results from dependence in the sighted adult on vision to evaluate somesthetic perceptions. When deprived of vision, the sighted adult is at a disadvantage compared to the blind individual who is not dependent on vision in making such judgments.

In a different view, Bartley hypothesizes (1953) that the sighted adult is at a disadvantage because he transposes tactile and kinesthetic sensations into visual images. His judgments follow the laws of visual perception which are not appropriate to the interpretation of tactile and kinesthetic sensations. The congenitally-blind person, unimpeded by visual images, judges tactile and kinesthetic sensations more accurately.

While each of the three views offers interesting possibilities, none accounts for the different findings in the present study on the two measures of kinesthetic perception. A fourth interpretation, timing, offers a more satisfactory explanation. Blind people report that they characteristically judge distance moved by timing (Valvo, 1971). Such a mechanism could account for superior performance of blind subjects on repetition of movement without also leading to the expectation of superior performance in other parameters of kinesthetic perception. For the present, this explanation is the most satisfactory.

The unexpected loss of accuracy on movement scores appears to be due to an actual decline in accuracy of perception when a long series of movements is made without feedback or knowledge of results. That loss of accuracy did not appear in the position scores is probably due to lack of precision in the scores. If the size of the error in position depends on the length of the trajectory as previous research has shown (Brown, Knauft, and Rosenbaum, 1948), a true increase in error size in the position scores could be masked by the randomization of trajectory length. When the actual

TABLE 7

Three-way Analysis of Variance: Influence of Visual Condition, Weighting, and Practice on Movement Scores

Source of Variation	df	Mean Square	F
Group Membership: Sighted, Blind	1	6.124	18.138[b]
Error	38	0.338	
Experimental Condition: Weighted, Unweighted	1	0.081	0.964
Group Condition Interaction	1	0.009	0.113
Error	38	0.084	
Practice Effect	39	0.060	1.511[a]
Group-Practice Effect: Interaction	39	0.035	0.882
Error	1482	0.040	
Condition-Practice Effect: Interaction	39	0.018	1.139
Group-Condition-Practice: Interaction	39	0.017	1.048
Error	1482	0.016	

[a] $p < 0.05$

[b] $p < 0.01$

TABLE 8

Means and Standard Deviations of Movement Scores for Sighted and Blind Subjects

Group	Mean Score	Standard Deviation
Sighted	1.069	0.175
Blind	0.982	0.185

TABLE 9

Three-way Analysis of Variance: Influence of Visual Condition, Weighting, and Practice on Position Scores

Source of Variation	df	Mean Square	F
Group Membership: Sighted, Blind	1	27.863	0.579
Error	38	48.118	
Experimental Condition: Weighted, Unweighted	1	1.532	0.226
Group-Condition : Interaction	1	8.242	1.215
Error	38	6.785	
Practice Effect	39	4.266	0.763
Group-Practice Effect: Interaction	39	6.605	1.181
Error	1482	5.590	
Condition-Practice Effect: Interaction	39	2.473	1.031
Group-Condition-Practice: Interaction	39	2.783	1.160
Error	1482	2.398	

TABLE 10

Means and Standard Deviations of Position Scores for Sighted and Blind Subjects

Group	Mean Score in cm	Standard Deviation in cm
Sighted	2.962	1.930
Blind	3.149	2.318

magnitude of the error in reproducing position was analyzed relative to the length of the trajectory, a significant increase in error did occur.[6]

Other researchers have observed a similar decline in performance in judging arm position (Horsley and Slinger, 1906). The decline in accuracy appears to represent a true loss of ability to interpret kinesthetic sensations when a long series of movements is made without feedback or knowledge of results. The findings can be related to Thorndike's (1940) theoretical position that knowledge of results is necessary for learning to occur. In a study which supports Thorndike's theory, Cole (1929) found that sighted subjects showed greater improvement in accuracy of tactile localization with knowledge of results than without such knowledge.

Contrary to intuitive expectation, adding a constant weight did not improve accuracy of kinesthetic judgments. Examination of the effect of weighting on individual performance in the present study also showed that the technique lacks clinical usefulness as it did not alter performance of individuals in any predictable way. The findings are similar to those observed in sighted subjects (Bahrick, Fitts, and Schneider, 1955). In fact, it appears with sighted subjects that if the weight is too great, it may function to increase error (Cohen, 1958). The usefulness of altering input to improve kinesthetic perception seems to lie in a more sophisticated approach where input is altered relative to the size of movement made (Bahrick, Bennett, and Fitts, 1955).

APPLICATIONS

Even though the sample included in the present study represents a very select group, the results and conclusions of the study can be drawn into the framework of general rehabilitation problems with the blind. The process of subject selection gave the impression that early total blindness is uncommon and that early-blind individuals run a high risk for multiple problems. With the exclusion of multiply-handicapped early-blind subjects, the sample included the exceptional rather than the usual blind person. Nevertheless, the results have relevance to the general blind population.

Evidence from the present study indicates that an adequate and even superior spatial model of the body can be developed without vision. The individual blind person who is handicapped in mobility or motor function is not necessarily deficient in body perception or in spatial organization of his body. Rather than representing inadequate body awareness, the motor handicap may indicate inadequate understanding of space outside the body.

Several observers have noted the difference between personal and extrapersonal space in the world of the blind person. After observing the slow motor development of a blind infant, Wilson and Halverson (1947) concluded from the child's behavior that he possessed adequate knowledge of his own body but not of space outside his body. Slinger and Horsley (1906) present quantitative evidence to support the interesting notion of differences between personal and extrapersonal space which requires further exploration.

The results of the present study underscore the importance of incorporating feedback or knowledge of results in techniques designed to enhance awareness of body sensation. The loss of accuracy without feedback observed in the present study suggests that mere repetition of movement is not itself sufficient to enhance body awareness.

Evidence from other studies emphasizes the importance of evaluating effectiveness of feedback mechanisms. Slinger and Horsley (1906) found, for example, that simply telling a subject he was right or wrong did not improve his kinesthetic judgments. In a study of accuracy of sighted subjects in drawing a three-inch line, Trowbridge and Cason (1932) found that telling the person the size and direction of his error led to much greater improvement in accuracy than simply telling him whether he was right or wrong.

SUMMARY

Careful consideration of the role of vision in structuring somesthetic sensations shows that a large number of variables play a role in body perception. Evidence from the present study, in which an effort was made to control the variables, indicates that an adequate and even superior model of personal space can be developed without vision. In regard to rehabilitation procedures, the present study shows that repetition of movement without feedback and alteration of input with weights does not improve functioning.

NOTES

1. Carr (1935) defines spatial attributes as size, shape, stability and motility, distance, direction.

2. Early blind was defined as light perception or less since age five or less. Studies of visual imagery in the blind show that conscious and unconscious visual memory is not retained if blindness occurs before age five (Jastrow, 1901; Schlaegel, 1953).

3. The weight was set on the basis of a pilot study at a level to preclude fatigue.

4. The data were submitted to analysis of variance designed for the special case of a three-factor experiment with repeated measures on two of the factors (Winer, 1962). The analysis is appropriate for experiments designed to study learning rates as a function of experimental condition.

5. The finding appeared during analysis of raw and transformed scores to determine which scoring methods would give the best fit of the data to the statistical model.

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Editor's Note:

The following statement was prepared by the Subcommittee on Sensory Aids of the U.S. National Academy of Engineering (NAE) for submission to its parent group, the Committee on Interplay of Biology with Engineering and Medicine of the NAE. The plan outlined has been extensively reviewed, and in November of 1971, the plan was approved for endorsement by the Academy.

In preparing the present version for publication in the *Research Bulletin*, it was thought at first that readers would not be particularly interested in the Academy Subcommittee's own statement of what the Academy might undertake; but in reviewing the material, it was felt that the reader, were he deprived of the whole content of the document, would lose much of the flavor and excitement of the original. It was decided, therefore, that the statement would appear more or less intact.

The membership of the Subcommittee comprises the following persons:

Robert W. Mann, Chairman
Charles W. Garrett, Executive Secretary

James C. Bliss	George Fellendorf
Leslie L. Clark	Leon D. Harmon
Franklin Cooper	Harry Levitt
Peter Denes	Patrick W. Nye

Inquiries about the statement may be directed to the Editor, to the Chairman of the Subcommittee, or to the Executive Secretary of the Subcommittee. Although the statement has achieved only limited distribution so far, it has created a good deal of discussion and interest. Since it is intended to generate discussion of ways in which the national (and by implication at least, international) goals of sensory research can be realized, I should like to emphasize that we welcome comments from readers, favorable or not, that would contribute to that discussion. It is my own feeling that the plan represents a striking departure in its scope, its unified view of the fields involved, and its insistence on a sustained effort to insure the delivery of the products of sensory research into the hands of users within reasonable time frames.

A PLAN FOR EFFECTIVE ACTION

There are nearly half a million blind people in this country, and more than four times as many with seriously impaired vision. The profoundly deaf number some 850,000 and an additional seven million people have seriously impaired hearing. If these people with sensory handicaps were brought together, the numbers of the blind and visually impaired would equal the populations of Memphis and Philadelphia, respectively; the deaf would fill Cleveland; and it would require Baltimore, Chicago, and Los Angeles together to hold those with seriously impaired hearing.

Not only are more than ten million citizens unable to lead normal and productive lives, but the nation as a whole is deprived of many of their talents. Despite this multitude who are without a primary source of information, sight or hearing, relatively little effective use has been made of modern technology to provide sensory aids -- devices to augment or replace the deficient senses. Instead, almost all of the funds allocated for the sensorially deprived are expended in ways which tend to maintain or increase dependence on the welfare system. Adequate technological aids offer the promise of lessening this dependence.

Sensory augmentation for both the blind and the deaf has been less than adequate because research and development have tended to be device

oriented, poorly supported, and fragmented. The same kinds of simple devices have been invented over and over again, and this will continue as long as we continue to use the lone inventor as our chief model for progress. In addition, too little attention has been given to sensory augmentation for very young children who may suffer permanent disabilities in the acquisition of language and spatial concepts if help is unnecessarily delayed.

We are capable of doing much more to help these people live better lives.

Three factors have impeded progress in the application of sensory aids. First, the very complexity of visual and auditory impairments and their consequences makes it difficult to define the problems to be solved. Second, a wide disparity and lack of coordination exists among the persons and organizations that provide funds, generate ideas, and have specialized knowledge, research facilities, and rehabilitation services. Third, the market demand for sensory aids is unpredictable in an already economically disadvantaged subpopulation; such a market is unlikely to encourage private venture capital for research, development, and evaluation.

To meet the needs of the blind and the deaf, a well directed effort is required that is funded and managed on a long term basis. We must use our advances in science and technology to provide the required basic research on information processing by humans and to develop useful devices and systems. A national program to do this could bring great benefits to the sensorially deprived everywhere. But the problems are diverse and complex, and progress will depend as much on creative management as on massive effort.

One important initial requirement is to create an effective means of communication among researchers, organizations, and workers for the impaired individuals, and the users themselves. Only with this interaction can a satisfactory balance between fundamental research and technological development be achieved. At present, development projects are often undertaken without basic knowledge of user needs and capabilities, sensory information processes, and the realities of deployment. Moreover, evaluation of the utility of specific sensory aids and the development of appropriate training procedures are practically nonexistent.

The scale of planning and organization that is needed for the overall effort calls for a substantial commitment of funds. Further, there are high costs of prototype production and field trials, and the potential for profitable sales is limited. Also, we may expect that when truly useful sensory aids become available, a great demand will be created; the organizational and funding resources that will then be necessary have yet to be estimated, planned for, and mobilized.

Our purpose here is to suggest a national program that can be instrumental in solving these problems.

THE NEEDS OF THE BLIND

Blindness limits the ability to read, to enjoy normal mobility, and to perform many everyday activities usually dependent on sight. It also precludes an enormously important means of esthetic communication; and it brings considerable economic disadvantage.

Sensory aids should, at the very least, equip blind people for reading text and for moving comfortably in unfamiliar surroundings. Such aids must extract complex information from the environment and present it to the user through his sense of touch or hearing or by making use of his residual sight. More useful aids that would assume some of the functions of the visual nervous system (thus serving as a substitute for actual vision) would obviously be still more complex and difficult to obtain, but they should be a long-range goal.

The work done so far has resulted in a relatively small and inadequate arsenal of sensory aids, largely due to the problems noted above--lack of coordination of long-range objectives, and of funding. Talking books, braille, and sighted

readers still are used (although inadequate) instead of portable reading aids or automatic text-reading systems which are technically feasible and potentially more flexible. In mobility, modern technology has had no significant impact; the dog guide and the long cane remain the most effective mobility devices in use.

THE NEEDS OF THE DEAF

Deafness, while not as conspicuous as blindness, is as serious. Not only does the inability to hear deny an important source of information, but in addition, deafness may impair a human activity of great importance--speech--and impede the development of the most important component of thought--language. Educational retardation of from three to five years is commonplace in an intelligent child who is born deaf or loses hearing before acquiring language. Speech comes slowly (and sometimes not at all) as the deaf student struggles to produce sounds he cannot hear. Social awareness and maturity are also frequently delayed because of the child's inability to learn through listening. A deaf child has far more potential for a self-supporting adulthood if he can learn to use speech and language effectively, yet most deaf children presently do not reach an achievement level much above eighth grade. It is therefore not surprising that 80 percent of deaf adults find themselves in unskilled, dead-end jobs. Thus deafness, like blindness, can impose severe economic penalties.

The three interrelated problems of deafness--those of speech, hearing, and language--require quite different approaches. A person who loses his hearing *after* learning to speak will usually retain his speech despite a tendency for the speech quality to deteriorate. On the other hand, those who are born deaf or those who become deaf very early will not independently learn to speak or perceive speech. These people require not only prosthetic aids to facilitate communication with others, but they also need some means of acquiring the abstract concepts of symbol manipulation on which all language depends. A relatively mild hearing loss can be overcome adequately with common hearing aids that simply amplify the important acoustic energy of speech. Persons with such partial loss may need only a sensory aid and some training in using it.

A variety of sensory aids for the deaf have been developed, and most of them have been directed to the problem of salvaging residual hearing. They operate either by giving as much useful sound amplification as possible or by transforming portions of the acoustic signal for use by intact parts of the hearing system or by other sensory channels. But even though the essential technology for such devices is well established, and the aids are ingeniously designed and earnestly applied, only limited utility has been achieved. For most of the devices, the design has been *ad hoc*, many of the user's perceptual requirements remain unknown, and training and evaluation techniques are rudimentary.

A PLAN FOR ACTION

The problems of the deaf and the blind are not identical, but there are similarities in their research, development of sensory aids, education, and deployment. Both groups need help in dealing directly with their surroundings on a day-to-day basis. Additionally, the congenitally deaf must learn the speech skills and language concepts necessary for normal development and social intercourse.

Basic research on the role of the unimpaired senses in learning about and communicating with the environment is essential to an understanding of the kinds of aids that could be used by both the blind and the deaf. Sensory devices can be developed to give blind adults access to the printed word and to give deaf adults access to the spoken word as well as the ability to monitor their own speech production. For both, other kinds of aids could improve their mobility in an environment the blind cannot see and the deaf cannot hear. For the very young deaf child, there is the urgent need for devices that will detect a hearing impairment early and for research to discover how these children can

acquire language. And for all concerned, education is crucial--for training the users of sensory aids and for preparing their teachers.

Thus the needs of both the blind and the deaf have four important elements in common:

1. Communication with the environment;

2. Engineering interfaces with physiological senses;

3. Education;

4. Synergistic organization and administration of science, technology, and human engineering.

The amelioration of the effects of blindness and deafness is a goal worthy of the best talent our country can bring to bear. Technology could do far more for the sensorially impaired than it is now doing or is likely to do until a concerted effort is made to develop and deliver effective sensory aids. Broad, sustained actions are needed to mobilize the scientific and economic resources of the nation. The organizational and research strategies for such an effort will involve diverse and complex problems. Solutions cannot be expected from individual inventors or from service organizations devoted to conventional welfare. Rather, what is required is a comprehensive program which embodies the following elements:

1. *Information.* Collection of demographic data; assessment of sensory needs; dissemination of information about relevant research in medical, psychological, and technological areas to planners, investigators, educators, the sensorially impaired, and the general public.

2. *Research and Development.* Identification of fundamental problems requiring basic research and of sensory aids meriting immediate development. Stimulation of research and development in university, government, and private laboratories. Performance of research (especially where the complexity of the problem or the scale of effort requires concentrated resources) and following through from that research to practical development.

3. *Evaluation and Deployment.* Assessment of prototype devices for technological, physiological, and psychological adequacy and for user acceptance. Development of systematic methods for the evaluation of sensory aids. Establishment of effective training and deployment procedures, particularly in educational settings.

4. *Funding.* Identifying and securing financial support for the operating program outlined above, for cooperative efforts with other organizations, and for the high cost of proceeding from evaluation in the laboratory to deployment and maintenance in the field. Without such follow-through, even the best of sensory aids lies fallow and useless.

Various kinds of organizational arrangements for carrying on the foregoing activities will need to be considered since each kind has merits and limitations. Although many of the more than 1,000 organizations currently providing service to the deaf or blind are useful, not one is adequate for the total program outlined above. New organizations are required, and it is important to determine how the existing ones will be utilized and interfaced. Although separate organizations will be needed to deal with problems of the visually impaired and with those of the auditorially impaired, the factors that affect the choice of organizational arrangement are much the same and may be considered together. Some alternatives that could achieve the desired actions are:

1. *National Centers*, created within the federal government to execute and to subcontract research, development, and deployment. Both intramural and extramural programs would be pursued. These mission-oriented federal centers would resemble agencies like the National Center for Health Statistics or the National Communicable Disease Center.

2. *National Laboratories*, existing outside of the federal government and probably associated with universities. Even though established in cooperation with the government and funded by it, these centers would operate independently. They would resemble such national laboratories as Argonne, Lincoln, or Oak Ridge.

3. *National Foundations*, independent of the government (at least initially) and neither funded nor operated by the federal establishment. They would be supported by foundations, universities (possibly via government contracts), and industry; however, they could be planned for eventual phaseover to federal support. One attractive variant is an independent center affiliated with a university and clinic and supported by a consortium of private sources. Small-scale models for such national foundations exist as research institutes attached to many universities; on a national scale, examples are the Woods Hole Oceanographic Institution, Carnegie Institution of Washington, and the Salk Institute.

For each of these ways of organizing the national effort there are obvious advantages and disadvantages.

National Centers have well-known precedents, and increasingly strong support is becoming available for health-service delivery systems. Further, there is great effectiveness in the capability for direct control and coordination of research and development activities; thus, even though such structures may be inefficient, much gets done. Such centers can be brought into being via direct Congressional action. But in so doing, a number of presently established jurisdictions must be disassembled and redistributed, not without controversy and resistance. Other major disadvantages are that, being large, the operation has much inertia and can become cumbersome and insulated. The National Centers could adopt a "seeding" approach with much advantage. For instance, an operation similar to that of the Peace Corps, specially trained young people could act as individual field workers. Trained and deployed by the Center, these workers could assist the existing service agencies and would be doubly welcome since they come with special skills and at no cost. With the resources of the Centers to draw on, these field workers could provide effective, immediate, and highly visible services to the blind and deaf.

National Laboratories would have an advantage in being able to start modestly but grow rapidly. Their quasi-independent status frees their operation in many ways and allows them to react swiftly. But the loose coupling to the federal establishment puts them at a disadvantage in undertaking large-scale, expensive operations such as the manufacture and deployment of devices or the operation of large-scale training or service centers.

National Foundations, separate from the federal government, may be relatively easy to initiate with support from one or more of the major private foundations. Such organizations can readily start small and develop support from government as well as from private sources as they show their value and potentialities. They can, however, lead only by example, and exert influence only by secondary pressure. Also, their growth rate may be too slow for their influence to be significant.

Other organizational arrangements, less ambitious and less adequate than these national establishments, might well serve as lead-in, relatively short-range approaches. Two such possibilities, not necessarily exclusive of each other or of the national organizations, are

1. *Interagency Coordinating Group(s)*, created within the Executive Branch of the Federal Government to guide in problem identification, to act as an information clearinghouse, and to integrate activities and reduce overlap among the many agencies serving the sensory-handicapped population, and

2. *Seeding Centers*, utilizing key individuals who would be deployed

as nuclei in university environments or elsewhere to initiate research, development, and small-scale evaluation and deployment of sensory aids. The principal aim would be to stimulate new researchers and to encourage new pilot projects. These individuals would be identified and encouraged by an informal central directorate such as the National Academy of Engineering.

Some of the advantages and disadvantages of these alternatives are easy to see.

Interagency Coordinating Groups offer the advantage of minimal perturbation to the existing system and of negligible cost. They could be brought into being by either executive action or legislative action. There is the disadvantage that such groups, if given power to *alter* agency programs, would be precedent setting and therefore unwelcome; conversely, if the groups were not precedent setting and given only the power to *advise* agencies, they would probably be relatively impotent.

Seeding Centers may start with modest initial costs. Moreover, they could be direct and natural expansions of the efforts of existing advisory groups such as the National Academy of Engineering's Subcommittee on Sensory Aids. But, being outside the federal structure, such centers lack the strength and scope required for a long-range and nationwide influence.

The foregoing plans for action at the national level are only outlines. The set of possible organizational arrangements may need to be expanded, but even the possibilities listed require elaboration and careful study of operating characteristics, feasibility, and opportunities for initiation. Moreover, these studies imply extensive consultation and data collection as well as analysis and integration.

RECOMMENDATION

The National Academy of Engineering, using the information and insights gained by its Subcommittee on Sensory Aids of the Committee on the Interplay of Engineering with Biology and Medicine (CIEBM) proposes the formation of a Sensory Aids Task Force which can immediately and forcefully initiate action. Operating as staff of the Academy and under the direction of an appropriate committee, such a Task Force should be established with the following specific functions:

1. Examine and evaluate various organizational and funding arrangements including those suggested above, and recommend courses of action with detailed plans for implementation.

2. Be responsible for the production of two major systems analyses documenting the problems of sensory deprivation and of sensory aids. These documents would result from an extensive study of the needs, the characteristics of existing service agencies, and alternative strategies for interfacing new organizations to those agencies to bring about the needed changes with maximum effect. With explicit, detailed documentation of the problems and of the existing establishment, formulation and implementation of a realistic long-range national plan can proceed.

3. Assume a number of short-range duties by functioning as a temporary action nucleus, identifying key personnel for future operations and initiating seeding activities. This includes planning and conducting exploratory conferences and hearings. It also includes stimulating the utilization of proven devices, especially those that lack only appropriate organization and funding. Such short-term actions could put useful aids quickly into the hands of those who need them while the broader long-range actions proceed.

The single most important function of the Task Force study is the development and implementation of a realistic long-term program to apply sensory aids in the amelioration of blindness and deafness. In a two-year period of time, concerted effort

on the part of the Task Force would result in the completion of a national program plan and implementation of the plan would be well under way. In addition and in parallel with the development and initiation of a coordinated national program, the Task Force would have operational functions, advising on research and development needs, serving as an information center, conducting topical conferences and workshops, and stimulating the evaluation and deployment of currently available devices and techniques that would have immediate payoffs to sensorially deprived people. A further, detailed discussion of key aspects of the program are presented in Appendix A.

The National Academy of Engineering is convinced that the goals presented in this Plan for Effective Action are both vital and achievable.

APPENDIX

NATIONAL ACADEMY OF ENGINEERING

SENSORY AIDS

DETAILS OF PRINCIPAL ACTION ITEMS (TWO-YEAR PERIOD)

The foregoing document describes the human needs and problems that arise from sensory deprivation, the help that modern technology could give, and actions that would mobilize that assistance. It recommends specific steps in those directions.

The central objective of these recommendations is the formation and implementation of an adequate, long-term action program at the national level. Other short-term objectives and the actions recommended to achieve them, while important and necessary, are supplemental and, in a sense, secondary.

The realization of these objectives will demand imaginative thinking and much hard work; basic facts must be collected, the views of many persons in government and the relevant private organizations must be ascertained, organizational plans need to be drafted, reviewed and redrafted, and much more. This is not a job for a volunteer committee alone. The need is for a full time professional staff with adequate supporting services--a task force of the kind recommended--to carry out the policy guidance provided by an Academy overview body such as the present Sensory Aids Subcommittee of the Committee on the Interplay of Engineering with Biology and Medicine, or a comparable successor group.

Three general assignments for the Task Force are recommended, primarily the planning and implementation of a long-range action program at the national level on a scale commensurate with existing needs and technological opportunities. The generation of such a program will require the collection and analysis of certain information needed for realistic planning, and it is proposed that the Task Force arrange contracts for these system studies. To do otherwise would require a much larger Task Force staff.

The second assignment is directed to current efforts. There is a need to continue to have expert consultation available in the field of sensory aids to guide ongoing and suggested research; to act as a liaison between researchers, educators,

technologists, and administrators (government and otherwise), to serve as a focal point for information; and to provide strong advocacy for those who need the advantages of sensory aids. The Academy overview body will immediately assume this capacity; the Task Force will provide professional staff support for these endeavors.

The third assignment concerns targets of opportunity, immediately realizable goals that are important in their own right, even though limited in scale and impact on the overall undertaking. One such activity that could contribute information useful for overall planning and would have immediate benefits as well is to conduct a few sharply defined conferences. Another is arranging for the deployment of proven existing devices which, though known to be beneficial, have not yet been distributed to those in need of them.

The recommendations in the Plan for Effective Action focus on the need for a Task Force and on its initial assignments. The following comments deal in more detail with these topics.

ACADEMY OVERVIEW BODY

We envision the Academy overview body as consisting of twelve people, six with primary expertise in blindness, six in deafness. They will constitute a Committee on Sensory Aids of the National Academy of Engineering. These individuals would be speech, hearing, and visual scientists, engineers of sensory aids, educators, therapists, and clinicians. They will comprise, as a nucleus, several members of the present Subcommittee on Sensory Aids. They would meet once a month to provide continuing direction to the staff of the Task Force. Each will be appointed by the Committee Chairman for a term of two years.

TASK FORCE

The implementing arm of the Academy overview body would be a salaried NAE Task Force on Sensory Aids consisting of an executive director, a professional associate, an administrative secretary, and a clerk typist. This full time staff would be augmented by consultants, engaged when specific need for short-term consultations on projects arise. As noted above (and detailed below in the section on Systems Studies) certain subcontracts will also be let to accomplish major tasks. The Task Force will operate for a two year period to accomplish its objectives.

CONFERENCES

The three conferences proposed in the budget and outlined below are intended to provide information vital to overall program planning, to provide an interdisciplinary interchange on topics which have received relatively little concentrated attention, and to produce immediate stimulus for new action:

CONFERENCE ON INTERMODALITY TRANSFER

A problem central to sensory prosthesis relates to presenting information that is normally available to one input channel to some other, substitute, channel. Thus a blind person must be given auditory or tactile signals, while a deaf person requires visual or tactile inputs. Virtually nothing is known about space-time trade offs, channel capacities, equivalent mappings, or interference with otherwise ongoing normal signal inputs. The purpose of this *dual* conference is to delineate the problems, chart research programs, and specify performance criteria which can lead to the most effective utilization of remaining sensory channels. These matters underlie all aspects of sensory aid.

The conference will be dual in that sensory intermodality specialized sessions, one for each handicap, will be held in parallel for two days. The blindness section will consider auditory and tactile surrogates for the separate problems of reading and mobility. The deafness section will consider visual and tactile surrogates for the separate problems of language acquisition and of communication. On the third and last day of the conference, the two sections will meet in joint session. They will

survey individual findings thus far and identify mutual scientific and technological research which can profitably be considered simultaneously for the future. The interdisciplinary discourse both in formal and in out-of-session contact should be especially useful among people who have similar aims, but who rarely attend the same conference. Of particular importance will be the cross-discipline discussions of problems of language representation, both written and oral, as they are central and common to both areas of disability.

A major output of this conference will be a concise statement of the state of knowledge of intermodality transfer, identification of the gaps in that knowledge, and recommended directions for future progress. A single volume of proceedings published in book form and intended for wide distribution will be produced.

CONFERENCE ON SENSORY AIDS FOR THE PARTIALLY SIGHTED

According to the administrative or economic definition of blindness, i.e., the so-called "legal" definition, the population of blind persons in the United States is approximately 420,000. Of these, only about 10 percent have no light perception at all; that is, about 90 percent have some residual ability to "see." If, instead, one uses a functional definition of blindness, the number of the blind is closer to a million. Of these, 80 percent to 90 percent are believed to have some residual vision. These figures do not take into account the additional four million or so who cannot be called blind, but whose vision is deficient to the extent that normal behavior is impaired.

Sensory aids for visual impairment typically are intended for the totally blind, hence are sensory replacements or prostheses. Though inadequate, there are many, both for reading and for mobility. Aids for the partially sighted are few in number, and they tend to be reading aids--mostly optical magnifiers and, more recently, closed-circuit television (CCTV) systems. The lack of variety and the relatively recent interest in CCTV attests to the undeveloped state of aids for the partially sighted.

This conference proposes to obtain a preliminary assessment, by classes, of visual functional disorders; to explore new avenues of technological application for aids in each class; and to obtain preliminary design parameters of a diagnostic, prescriptive, delivery system for aid to the partially sighted. The intent is to match with accuracy residual sight to specific aids for closest approximation to normal visual perception and behavior. This is analogous to its relatively well developed counterpart in audition, the hearing aid system. A major goal of the conference is to define and recommend effective, modern, functional, diagnostic tools (as in the more refined audiometric tests) for clinical application, replacing the old and relatively ineffectual Snellen chart measurements.

The participants, about fifteen in number, will be clinicians, ophthalmologists, engineers, and administrators of government, hospital, and rehabilitation agencies serving the visually impaired.

The conference will last for three days in an isolated location set up for close, uninterrupted interaction among participants. A proceedings will be published and widely disseminated.

CONFERENCE ON TECHNOLOGY, LINGUISTICS, AND EDUCATION OF THE HEARING IMPAIRED CHILD

The extent to which modern communication technology and new, emergent linguistic insights can be brought to bear on the education of the hearing impaired child is largely unknown. Both disciplines relate significantly to problems of the young deaf, ranging from techniques for very early diagnosis to effective teaching of language concepts.

One of the results of the recent Conference on Sensory Aids for the Hearing Impaired[1] conducted by the Subcommittee on Sensory Aids was the realization that educators of the deaf, though charged with the very challenging task of teaching language,

speech production and speech reception to a deaf child, have very little knowledge of the science of these processes or of the engineering technology available to assist the educator. Nor does the engineer working in the sensory aids field possess adequate knowledge of the objectives of the educator, the techniques he uses, and the problems faced in the classroom.

The prime objective of the proposed conference is to initiate actions which will close these gaps, for such is required if sensory aids are to be properly designed and used. A major item for discussion will be the development of methods which, during the preparation of teachers of the hearing impaired, will equip them with the adequate knowledge of the physical and linguistic structure of speech and the elements of modern communication technology which can be applied to the education of the deaf child. At the same time, engineers in attendance will be given further insights into the education of such children and the linguistic and speech science fundamental to that education.

The participants, numbering no more than twenty, will consist of leading researchers in speech and linguistics, educators of the deaf and engineers working the sensory aids field. The conference will last for two and a half days and will be held in a secluded, self-contained establishment geared for informal discussion between and after formal sessions. As with the other conferences, the record of this meeting will be documented in a proceedings for world-wide distribution.

SYSTEM STUDIES

SYSTEMS ANALYSIS OF THE BLIND AND VISUALLY IMPAIRED

An effort devoted to enhancing the lives of Americans suffering visual or auditory impairment through the provision of sensory aids must start with the best possible information on the stage of the system which it proposes to change. Fortunately a significant part of this preparatory work has already been done through a year-long study[2] in 1967-1968 undertaken by the Organization for Social and Technical Innovation (OSTI) under the sponsorship of the National Institute of Neurological Diseases and Blindness (now National Institute of Neurological Diseases and Stroke). This assessment concluded that, among other things, for the year 1966 the cost of providing services through the official "blindness system" was 446 million dollars while indirect welfare, social security, veteran's benefits, etc., added an estimated 200 million dollars. This does not include the contributions of the "informal system--families, friends, etc." which if converted into dollar value might well exceed the entire cost of the official or agency system. Over 800 official agencies vied for the opportunity to offer services to the most attractive clients--the singly handicapped educable child or employable adult, with the consequence that perhaps only 20 percent of the affected patient population interacted with the system at all, but those who did tended to receive the best available services.

However useful as a pioneering effort, the OSTI study is largely retrospective, and since technology has had so little effect on aid to the blind, that study included no consideration of the consequence to the system of the provision of sensory aids. In fact, the report recognized that the creation of ". . . new alternate forms of service training, devices, and care becomes imperative in order to provide options available to the visually impaired. . . ." We believe that technology can greatly expand and enrich these options.

The system study we propose will differ from the OSTI study in two significant ways. First, as indicated above, it will be oriented to show not only what has happened, but more important, what changes are required and what constraints exist. Second, it will embrace a much larger system than that including the profoundly blind; it will be concerned with the partially sighted as well.

To project and guide the development and delivery of an armamentarium of sensory aids, we need more and

better data that will assess the *functional consequences* of blindness (as contrasted with ophthalmological measures such as the Snellen chart), and that will assess the *functional capabilities* of the blind and visually-impaired population. The study proposed here would gather such essential data by survey techniques akin to the Grey and Todd study[3] conducted on behalf of the National Health Services in Great Britain. These data, for which there are no equivalents in the United States, describe the mobility and reading proficiencies of that population. Such baseline data are essential to any long-range study which proposes to change the daily effectiveness of the visually impaired. Outcomes can then be measured relative to this assessment of the initial state of the affected population. Furthermore, the data are essential for establishing rational priorities and realistic goals for sensory aid research and development options.

The OSTI report emphasizes the chaotic, competitive, and frequently self-defeating nature of the fragmented 800-agency official system. The provision of effective sensory aids and training in their use will impose entirely new requirements on the "blindness establishment" calling for talents and capabilities which it may not be able to muster. The presently proposed study will inspect existing service agencies, training and rehabilitation institutions, educational facilities, etc., from the point of view of their adaptability to the new demands of more technologically oriented service, training, and maintenance. This information will be essential in determining whether the present system can be developed to assume this new role or whether an entirely new system will be mandatory.

SYSTEMS ANALYSIS OF THE DEAF AND HEARING IMPAIRED

More and more knowledge is becoming available about the origins and nature of hearing disorders, about their communicative, educational, and social impacts, and about ways of combating these handicaps. No overall survey of the needs of the hearing impaired and of ways for meeting these needs has yet been undertaken. The previous studies of etiology and demography, partial and desultory, have had virtually no impact on the system of services for the hearing impaired. The purpose of the proposed system analysis, therefore, is to provide a comprehensive study to identify the needs of the hearing-impaired population, to survey the engineering procedures for maximizing existing measures for meeting these needs, and to develop new measures where necessary; and to identify the nature, capacity, and shortcomings of the present system that provides services. This systems study would, in effect, study the "deafness system" much as the OSTI study examined the "blindness system," but with a focus on how the system can be best utilized to develop, evaluate, and deploy sensory aids.

The proposed systems analysis therefore will be concerned with the following three topics :

1. Survey of the needs of the hearing-impaired population, using and extending the work of the National Center for Health Statistics, the Office of Demographic Studies at Gallaudet College, and others. It will document demography, educational requirements, social and vocational problems, sensory aid technology for language teaching and communication, and diagnostic technology for early detection and routine assessment of impairment at any age.

2. Survey of existing agencies that provide service for the hearing impaired, to include government agencies, private organizations, foundations, industry, universities, and professional organizations.

3. Identification of new organizations that are required, both technological and educational, including specification of currently available services for the deaf, identification of insufficiencies in those services, and analysis of ways to establish and interface new agencies with the existing system.

The Subcommittee has examined the funding requirements for each of these studies, which it is proposed be subcontracted to a management consultant organization (profit or non-profit). The subcontractor will be selected after competitive proposals are solicited and evaluated by the Overview Body and Task Force. About two and one-half man years of professional effort are envisioned for each study, to be accomplished in a one-year period of time.

The program laid out for the Sensory Aids Task Force is of significant magnitude; it embodies the construction and initiation of an integrated national sensory aids effort and, at the same time, includes specific operational short term projects to apply currently available knowledge and prototype devices to those who can benefit from them. The Subcommittee believes that support for this program should come from a variety of sources: mission-oriented and research-oriented federal agencies, and from private foundations whose objectives are consistent with the amelioration of handicapping conditions.

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JOINT ENTERPRISE UNDERTAKEN BETWEEN TWO CENTERS FOR DEVELOPMENT AND EVALUATION OF A TACTILE COMMUNICATION AID FOR DEAF-BLIND PERSONS*

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INTRODUCTION

A unique joint enterprise is presently in progress by the National Center for Deaf-Blind Youths and Adults (operated by The Industrial Home for the Blind under an agreement with the United States Department of Health, Education, and Welfare) and the MIT Sensory Aids Evaluation and Development Center. Prior to the creation of the National Center, the Anne Sullivan Macy Service for Deaf-Blind Persons of The Industrial Home for the Blind, a research and demonstration program conducted with the help of grants from the United States Social and Rehabilitation Service of the Department of Health, Education, and Welfare, recognized an urgent need for a tactile communication system for deaf-blind persons. This need was apparent in home, industrial, and residential environments.

Deaf-blind persons use many contrivances for doorbells and other simple communication devices. Some doorbell accouterments, for example, consist of fans and heavy tactile buzzers strategically located throughout a dwelling or residence that are attached to an ordinary doorbell system. With the new telegraph devices currently being attached to telephones which allow coded communication between deaf-blind people, a tactile telephone ring indicator is needed.

To our knowledge, no electronic communication systems for deaf-blind workers exist in industrial settings. A deaf-blind person must be contacted in person by another worker or supervisor if a message is to be delivered. Loud speakers or traditional call systems are of no value to a deaf-blind worker. In case of fire or fire drill, deaf-blind persons must be contacted personally, which ordinarily presents no real problem except where the flames or smoke might isolate the deaf-blind worker.

Deaf-blind clerical and professional people have expressed a need for "end of line indicators" on braillers and typewriters. The bell is of no help, whereas a vibratory message would eliminate the need for tactually experiencing with the hand the end of a braille or typed line. This group of professional and clerical deaf-blind persons also expressed a need for an office call system

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that could be used to announce a visitor or colleague.

Mobility instructors working with deaf-blind clients who are learning to commute in urban areas have wanted for many years a signal device that would allow them to follow their client on heavily traveled streets beyond the range of physical contact in order to direct them in the process of teaching maximum independent travel skills. Problems such as these, dictated that development and evaluation of a remote-control tactile communication system be established as a first priority for aid research projects.

With the establishment of the National Center on June 24, 1969, funds were made available for research in evaluating systems such as the one discussed in this paper. After soliciting proposals from several development centers, the National Center awarded a contract of evaluating the tactile communication system, hereafter referred to as TAC-COM, developed by the MIT Sensory Aids Evaluation and Development Center. Jointly, the needs and problems of a tactile communication system were explored. As these concerns became clarified, the Sensory Aids Evaluation and Development Center developed, proposed, and demonstrated a prototype system devised to meet the specified needs. The immediate feedback to the engineers at periodic intervals during the evaluation of the prototype system has furthered its development.

Discussion of the technical aspects and the evaluation of TAC-COM along the following parameters is considered in the balance of this paper:

1. Technical Development of the System

2. Fire Alarm System

3. Doorbell System

4. End of Line Indicator

5. Mobility Aid Systems

6. General Communication Systems
   a. Time Clock
   b. Office Call
   c. Telephone Ring

TECHNICAL DEVELOPMENT

The Center for Sensory Aids Evaluation and Development (SAEDC) has been responsible, with the help of its consultant staff, for the design and development of a vibrotactile communication system, known as TAC-COM. The system was then demonstrated to members of the staff of The Industrial Home for the Blind to be considered as a potential solution to some of the communication problems of the deaf-blind.

The initially proposed program for TAC-COM was to investigate and evaluate the system as a doorbell and fire alarm communication device in environments which house deaf-blind persons.

Preliminary investigations were conducted at SAEDC prior to the demonstration at the National Center to determine the coverage field and effectiveness of the system in a confined location. Rectangular induction loops were erected in a location set aside for this purpose and field test measurements were made to determine the field strength throughout the environment. It was found and verified that the minimum loops required to cover adequately a small location such as a room, were two loops erected on perpendicular and adjacent walls. Large locations required the installation of a number of loops to assure complete coverage. To demonstrate this, an office area 20 by 20 feet was tested with two perpendicular rectangular loops and then a larger environment covering an area of 40 by 80 feet, was tested to determine field coverage requirements with respect to the number of loops needed. A single loop did create nulls in some locations and was considered an inadequate installation.

An important parameter to determine coverage and to assure communication is the height of the loop; the higher the loop the greater the coverage.

The TAC-COM system consists of a sender and a receiver and utilizes induction field principles as the communication link. The receiver vibrates when it receives a signal from the induction field, and is worn on the person in a convenient

pocket or, if necessary, a holder. The length of signals or vibrations can be varied according to a code preselected by the operator of the transmitter. The receiver is a battery-operated device which is approximately the size of a package of cigarettes and weighs about six ounces. In order to maintain reliable operation, the receiver should be recharged every twenty-four hours or at shorter intervals depending on the usage. The transmitter is an amplifier-transmitting system which is connected directly to the tuned induction loops.

The reasons for selecting a system which utilized induction field principles can be summarized as follows:

1. Interference due to external source and extraneous systems is considerably reduced,

2. Transmission of signal is confined to small locations and will not infringe on FCC regulations,

3. Low powers are required to transmit the signal in desired locations, and

4. The system can easily be constructed and requires no exotic engineering techniques and circuitry.

EVALUATION OF TAC-COM AS A FIRE ALARM SYSTEM IN A REHABILITATION CENTER

TAC-COM was installed in the temporary headquarters of the National Center, measuring approximately 150 feet long and 75 feet wide. Five loops of number 12 wire, 18 feet high were placed in the building, one loop on each of four walls, and one loop erected in the center of the building. Lead wires from each loop were then connected to the transmitter. Ten clients in training during the evaluation period were asked to wear a TAC-COM receiver and were instructed that its vibratory message was a fire alarm signal.

In the first phase of this study the TAC-COM system as a fire alarm was compared to the traditional method used by The Industrial Home for the Blind, which consists of a supervisor or fellow worker tracing an x with the finger on the back of the deaf-blind worker. Time from beginning of first alert to total evacuation was recorded on 26 fire drills over a period of four months, 13 of which were TAC-COM and 13 x-method drills. No statistically significant differences were found between the two methods. However, needless to say, these were only fire drills, and the hazard of a deaf-blind person being isolated by fire and smoke were not investigated. TAC-COM could be invaluable if such isolation were the case.

The second phase of the fire alarm evaluation consisted of comparing the x procedure with the TAC-COM system from time of first signal to the first purposeful movement of individual clients which indicated an awareness of the fire drill. Differences were found with this approach of measurement with TAC-COM proving better. These findings were expected because of the time needed for a helper to trace x's on the back of each client with the traditional method.

Phase three of the evaluation pertained to client attitudes toward TAC-COM. Interviews with each client who had enough language facility to express his ideas about the instrument were conducted. Four out of nine clients with communication ability thought well of the TAC-COM, two complained about not having a pocket to put it in, two said the clip was unreliable, and one client said it was too heavy. These attitudes about TAC-COM were sent to the Sensory Aids Evaluation and Development Center for consideration. As a result, all of the clips on the receivers were replaced and fastened more securely to the units. The idea of enclosing each TAC-COM receiver in a shoulder or belt holster was also considered and these holders are now being developed.

A final phase of the National Center TAC-COM fire alarm evaluation consisted of isolating difficulties with the system as a whole. The center loop presented a tripping hazard as it crossed the floor of the building in a heavily traveled

section of the National Center. It was later found that the system was still reliable with the center loop disconnected and consequently it was removed. The engineers at MIT also found that a metal strip cemented to the floor in place of the wire worked adequately for buildings in which central loops might be mandatory. As a fire alarm system the TAC-COM is reliable and functions as expected.

TAC-COM AS A FIRE ALARM SYSTEM AT A LIGHT INDUSTRY ESTABLISHMENT

Currently, a TAC-COM system is being readied for installation at one of the departments of the sheltered workshop of The Industrial Home for the Blind. The primary function of this department is the construction, packing, and shipping of mops. Eight deaf-blind persons are currently working in this department. Preliminary surveys of the shop in question highlighted several problems:

1. Several doorways and one elevator shaft create a problem due to the necessity of wiring across openings.

2. It is a large area, measuring 175 by 60 feet, and filled with much heavy electrical equipment. For these reasons the consulting and developing engineers thought at least one and possibly three central wires might be necessary to cover the entire area effectively. These central loops would dictate crossing heavily traveled work lanes with a number of wires, once again creating a tripping hazard.

When the Sensory Aids Evaluation and Development Center was confronted with these problems, alternatives were suggested as to how the center loop might be installed. Again, a suggestion made by engineers at SAEDC was that a metal strip be cemented to the concrete floor to substitute for the bottom portion of the rectangular loop. This might eliminate the hazard of tripping and stumbling of clients and workers. However, it was found upon further investigation that it would be difficult to install a metal tape to substitute for the wire since the floor surface did not lend itself to the solution.

An alternative to the solution of installing vertical wire loops was carefully investigated at SAEDC. After several tests and careful measurements were completed, a recommendation was made that the vertical loops could be replaced by a single horizontal loop in the workshop area. A single horizontal loop would encompass the entire workshop area. This would require that the receivers be maintained horizontally as compared to the vertical position in a pocket since the induction field would be altered 90 degrees. A further change required to accomplish this would be that all receivers be placed in holders and supported by belts. This recommended system will be installed in the light industry establishment, and an evaluation program will be conducted to determine its effectiveness as a fire alarm warning system.

TAC-COM EVALUATED AS A DOORBELL

TAC-COM was installed in the two-bedroom apartment of Dr. Robert Smithdas who is deaf-blind and is Director of Community Education at the National Center. Original plans were to place loops on all four sides of the entire apartment but because of the numerous wires that this would involve, it was decided to loop only the centrally located kitchen to see if the system had power enough to cover the entire apartment. At the time of this report, the doorbell was working as expected with only two very slight nulls in remote areas of the apartment due to the experimental reduction of the loops. Because of their location at the extreme ends of the apartment, the probability of these nulls creating any functional problems is highly limited. The system sends a strong dependable signal as anticipated.

The New York City Electrical Wiring Code prohibits tying extraneous electrical equipment into the feeder lines of apartment houses. Therefore, SAEDC developed a sound

switch (a microphonelike device). The sound switch was placed at close proximity to the existing apartment buzzer which was used to activate the TAC-COM transmitter. The sound switch has been found to be a highly reliable and efficient device. It can be used to convert many auditory cues to tactile responses. The doorbell hookup in Dr. Robert Smithdas' apartment was not affected by extraneous noise present in the environment.

After using the doorbell for a period of two weeks, Dr. Smithdas reports that the system is reliable, sends strong messages and has allowed his friends to signal with individualized, predetermined codes from the street entrance. Dr. Smithdas also recommended that stronger, more reliable clips be put on the receivers. Consequently, this was done.

TAC-COM USED AS A MOBILITY TRAINING DEVICE

A study is presently being considered for testing a hypothesis that immediate feedback about veering behavior using a vibratory signal is superior to traditional delayed feedback or physical contact methods. To help test this hypothesis, the SAEDC developed a portable wireless version of TAC-COM. This instrument utilizes the same receivers previously described. The transmitter, however, is portable and is operated by a rechargeable battery with an operational range of five feet. This will make it possible to give trainees different remote control signals with TAC-COM for right and left veering behavior as they walk on a mobility training grid.

END OF LINE INDICATOR

The success of technically innovative communication devices is related to the number of applications which can be applied to the system and to its utility and efficiency of operation in the respective functional areas. It is felt at MIT SAEDC that TAC-COM has many useful applications which will help bridge the communication gap with deaf-blind people. The system has a simple vibro-tactile display which can be coded as to length of vibration.

An initial investigation examined the TAC-COM system to substitute for bells, i.e., a vibration would correspond to a bell ringing. An excellent example of this is an end of line indicator for the braille-writer and typewriter.

EXTENDED APPLICATIONS AND OTHER PROJECTED USES FOR TAC-COM

It has been suggested at SAEDC that other applications exist for the TAC-COM system and plans are currently underway to investigate other uses for TAC-COM.

SAEDC has installed in its present on-campus MIT facility a complete TAC-COM system. The entire center has been wired for total coverage in order that the system can be tested for various purposes. Members of the staff carry TAC-COM receivers which are presently used as a calling or annunciator system. Each staff member is given a code in order that the administrative assistant can communicate with each person. The TAC-COM transmitter is also connected to the telephone ringing circuit to inform members of the staff that the telephone is ringing via the corresponding vibro-tactile sensations.

A sound switch (or microphone) has also been incorporated in the TAC-COM system for experimental reasons. The sound switch sensitivity can be varied or adjusted to indicate or detect various levels of sound cues. For example, noises, whistles, bells, claps, taps, and general environmental noises can be detected. Experiments are being conducted to determine the usefulness of this accessory device to the TAC-COM system for deaf-blind persons.

Other projects will evaluate TAC-COM at the National Center for Deaf-Blind Youths and Adults to convert a time clock and bell ringing system to indicate class changes, coffee breaks, lunch periods and end of day, using the vibro-tactile display as a substitute for the bell.

SUMMARY AND CONCLUSIONS

The joint enterprise undertaken between the Sensory Aids Evaluation and Development Center and the National Center for Deaf-Blind Youths and Adults has led to the creation of a promising vibratory communication aid for use by deaf-blind people. this system has proven effective thus far as a:

1. doorbell,
2. fire alarm, and
3. as the basis for building a tactile display system that promises to have many uses for not only the deaf-blind but the deaf community as well.

This project also demonstrated that two agencies, one rehabilitative, the other technical, could cooperate closely in a complex project and that an important aid for the handicapped could result from this cooperation. As this paper is being prepared, other cooperative ventures are being considered.

BODY IMAGE AND BLINDNESS: A REVIEW OF RELATED THEORY AND RESEARCH*

Don L. Walker**

THEORY

HISTORICAL PERSPECTIVE

Modern theory with regard to body image can generally be classified according to one of two approaches. One of these has been traced as far back as Freud (Gorman, 1969).

The Freudian Construct. The Freudian approach, according to Gorman, is a special case applying Freud's idea of "image" to the human body. The Freudian image is considered to be the accumulation of all perceptions which concern an object, but which are not within the area of awareness.

Horowitz (1966) indicated acceptance of the Freudian idea to a degree. However, he conceded in an indirect way that this approach might be too limited, by stating that body image *may* operate outside of awareness, rather than making this an essential characteristic. Horowitz also suggested that certain body image phenomena can be learned, and that body image accuracy could have a profound effect on the interpretation of sensory input. In this respect, Horowitz occupies a position somewhere near the midpoint between the Freudian and the sensory-motor approach, which will be discussed next.

The Sensory-motor Construct. The sensory-motor approach to body image has origins in the literature of medicine much earlier than Freud, the first written account of body image disturbance having been attributed to Ambroise Pare in the sixteenth century. However, it was left for Henry Head, the British neurologist, to synthesize and describe the parameters of the concept of body image and set the stage for future development (Kolb, 1959). Head was interested in the body image as a dynamic entity which could be and indeed was affected and modified by all sensory input, and which also was capable of contributing profoundly to the qualitative interpretation of input.

Head has described an extremely courageous experiment which he undertook to determine the nature of various levels of sensory input which might have a bearing on an individual's consciousness of his own body and its parts (Head, 1920). In this experiment Head had a nerve in one of his arms divided surgically and reconnected after the removal of a small segment. Then, with the help of a friend, he studied the return of sensitivity to the affected area of the hand.

One result of the study described above, in combination with studies involving amputees, patients with neurological and other diseases, and surgical patients, was the development of Head's theory of body image which was to become the basis for much research and subsequent refinement of the concept over the following two decades.

Head developed a postural model of the body, consisting of the integration or unity of past experiences and current sensations, and

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*Excerpted from the doctoral dissertation *The Effects of Training on the Body Image of Blind Children of Kindergarten Age.*

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theorized that this model facilitated the individual's motor activities through constant relationship of the body with other objects. This model also was extended to enable the projection of the posture, movement, and locality beyond the physical limits of the body. In Head's words, for example, a woman's postural image extended "even to the feather in her hat."

Most of the modern writing on the sensory-motor aspects of body image refers to Schilder's work (1950). Indeed, Schilder made a great and important contribution to the understanding of the body image concept in psychological terms. However, in his development of a three-dimensional conceptual model of the body image (physiological, libidinous, and sociological), Schilder relied heavily upon Head's earlier research and writing.

Concurrently with Schilder's most productive period in this area, Troland was also working on development of a postural theory which was to become an integral part of modern thought regarding body image. If Troland did not borrow directly the results of Head's earlier work, his approach and conclusions show strikingly similar thought. Troland based his theory upon the consideration of body posture, its analysis, and its effects on perception.

Troland wrote,

> ". . . posture is reducible primarily to patterns of relative angular disposition of the various portions of the skeleton. . . (and). . . movement may be regarded as ordered successions of progressively different postures. . . " (Troland, 1929, pp. 366-7).

Perception is thought of as developing in a direct relationship to the individual's consciousness of these postures. The "postural-tonic" approach has been further developed by Lashley (1942), researched by Werner and Wapner (1949), and applied to problems of orientation and mobility in the blind by Siegel (1966). The influence of Troland *et al.*, also may be seen in the neurogeometric theory of perception of Smith and Smith (1962), and in Gibson's writing on the senses considered as perceptual systems (1966).

The postural-tonic theory and its variations have been the basis of numerous programs of education and research in the area of perceptual-motor development and its effects on learning. Kephart (1960) and his numerous colleagues, Getman (1964), and Barsch (1967), are just a few of those who have developed and researched programs in this area. While some of the claims for these programs have been unjustified by the results, it appears that they are not entirely devoid of value, and further inquiry is justified.

BODY IMAGE AND HUMAN DEVELOPMENT

An examination of some examples from the theoretical literature reveals considerable support for the position of body image as one of the basic components of human development. Especially in early childhood there exists a close relationship between mental and physical activities (Jersild, 1954; Kephart, 1960), and this relationship has such a profound influence on development that even higher forms of learning seem to have their roots in motor learning (Cromwell, Baumeister, and Hawkins, 1963; Dunsing, 1966).

In Piaget's developmental schema (Piaget, 1952; Flavell, 1963) sensorimotor intelligence is the earliest stage of intellectual development. Likewise, Bruner's (1961) inactive stage, essentially a sensory-motor concept, is also the first stage of a multistage developmental scheme. Both of these stages relate to and develop out of the child's physical interaction with his environment.

In a more limited sense, body image itself is considered by some child development authorities (Kagan and Moss, 1962; Ilg and Ames, 1965) to be a developmental concept. This would certainly be consistent with the theories of Head, Schilder, and others who see body image as a concept which normally develops and is refined as the result of motor and visual experiences.

Kephart, in the first work in his Slow Learner Series (1960), treats body image as a developmental concept which is basic to more advanced learning.

SPATIALLY-COORDINATED BEHAVIOR AND BODY IMAGE

Howard and Templeton (1966), developed a model of spatially-coordinated behavior which is based upon the responses of an individual to perceived stimuli as they are modified or conditioned by the internal constraints of the body and by environmental and ecological constraints. Since what is perceived is in large measure a function of the point from which observations are made, the body, as the observation platform, has a great effect on the quality of perception. Therefore, the condition of the body, especially including any physical handicap which exists, may deeply modify the perceptions the individual has of himself and his environment (Combs and Snygg, 1959). In a sense, the individual's consciousness of his body and its representation contributes to his organization of, and functioning in, external space. (Durat-Hmeljak, Stambak, and Berges, 1966.)

BODY MOVEMENT AND PERCEPTION

Smith and Smith (1962), through a review of relevant research by others and integration of this with their own research, developed their neurogeometric theory of perception. In this they stated that the only valid understanding of perception at any level is in terms of the movements that define it (p. 7). They defined three types of movements which contribute to the perceptual activities of detection and discrimination. These are (from most primitive to most sophisticated)

1. Postural movements - the large movements of the body, which regulate body position in relation to the forces of gravity and acceleration.

2. Transport movements - movements of members of the body, including receptors (e.g., eyes) through fluid space. Transport movements are intrinsically organized, mainly according to the bilateral symmetry of the body, with right and left members moving together or in opposition.

3. Fine manipulation of terminal members or the receptor systems of the head - these are controlled according to the dimensions and position of objects, (pp. 6-7).

J. J. Gibson developed his own theory of perception, in which movement in space is a major component, particularly of the tactile-haptic system (Gibson, 1966). In Gibson's view constant perception of objects in the face of constantly changing conditions depends upon the individual's ability to detect invariants, and movement of the body or some part thereof relative to the stimulus object is the major activity through which invariant characteristics are sought. Knowledge of the invariants of the perceiving mechanism (the body) must be at the heart of the system.

Getman and Kane (1964) have developed a readiness program based in part upon the hypothesis that if symbols (letters and combinations) are related to the child's physiological experience, formal learning, especially reading, will be facilitated. The program consists of gross body movements for general coordination, practice in balance using the walking beam, eye-hand coordination, eye movements, perception of basic geometric forms, and practice in visual memory. This program has been suggested primarily for children with learning problems, especially in reading.

BODY IMAGE AND PERSONALITY

Much research and writing exists regarding body image and personality development. A representative sample of theoretical writing is taken from Ausubel (1952). Ausubel adapted the Schilder (1950) definition of body image, the mental picture each individual has of his body, and conceived it as a basic component of his model of the personality (Fig. 1).

It will be noted that consciousness of the physical appearance of one's body in space is the base upon which the remaining components are added to develop the personality. Further, Ausubel (1958) thought of the body image as a changing, developing phenomenon in the child, with the most rapid change occurring during adolescence. He stated that body image is either a positive or negative contributor to self-esteem, but not neutral. Whether it is positive or negative depends on the social valuation of physical traits, deviations, and/or disabilities.

PERCEPTUAL-MOTOR BEHAVIOR, BODY IMAGE, AND BLINDNESS

Schilder (1950), in his discussion of Liepmann's "plan for action" theory, stated that the knowledge of one's own body is an absolute necessity. In his outline of the basic components of a plan for movement he also included knowledge of the particular body part to be utilized, and the object of the action or movement, either within one's body or outside it.

However, for all his clarity in definition of the concept of body image, Schilder made a rather obvious logical error with regard to movement. He stated,

> "It seems that either an optic perception or an optic image is necessary for the beginning of a movement," (p. 52).

If this statement were to be accepted literally, then congenitally totally-blind persons could logically be expected to be incapable of movement.

Von Senden (1960) seems to have been afflicted by the same problem regarding vision as Schilder. Von Senden made an extensive study of persons, blind from birth or very early in life, who had vision restored by surgery after they became adults, in which he repeatedly referred to space as a wholly visual term which a blind person is incapable of understanding. For example, he stated that

> ". . . no real perception of space has occurred at all, before the operation, and hence. . . everything spatial is a complete novelty to the patient," (p. 283).

Revesz (1950), on the other hand, assumed the ability of blind persons to perceive space haptically, and such a position allows for the reconciliation of visual and haptic space as noted by Smith and Smith (1962), and Gibson (1966). In Revesz's view movement of the body precedes objective spatial perception, or at least is a necessary condition for it, rather than the other way around, as suggested by Schilder. Van Weelden (1967) theorized a haptically organized space for a blind person, with the body in motion as the organizing mechanism. Space was defined by Van Weelden as "a possibility of movement." Like Revesz, Van Weelden considered body

<u>Body Image</u>	+	Auditory images of one's name Kinaesthetic sensations Visceral tensions Personal memories		=	<u>Self</u>	+
Self-attitudes Self-ideals Self-motives Self-values	=	<u>Ego</u>	+	Other non-ego involved: skills habits memories, etc.	=	<u>Personality</u>

Figure 1. Ausubel Model of Personality

movement as necessary to the experience and organization of space. Thus we see the body in motion as a requirement of spatial experience and organization for blind persons.

MOVEMENT AND PERCEPTUAL DEVELOPMENT IN THE VISUALLY IMPAIRED CHILD

It has been suggested (Elonen and Zwarensteyn, 1964; Fraiberg, Siegel, and Gibson, 1966; Fraiberg, 1969) that early visual impairment, coupled with concomitant restrictions on mobility, and on motivation to movement, may be responsible for late attainment or lack of attainment of certain developmental steps unless special attention is given. For example, Fraiberg, et al., (1966) suggested that there is no apparent use of sound as a component of object constancy concepts or search behavior in blind infants earlier than the tenth or twelfth month. Sighted infants, on the other hand, are able to employ vision and sound in search behavior at the fourth or fifth month.

Halliday (1970), in a description and discussion of the development of the preschool age visually-impaired child, stated that the child must know how to move about and use his body, and how to move in space in different ways, in order to develop self-confidence, gain meaning from his environment, and develop the basic skills for school-related learning.

RESEARCH

BODY IMAGE AND PERSONALITY

Body Cathexis and Behavior. There is an apparent relationship between the degree of discrepancy between a child's own body image and his conception of the cultural ideal, and anxiety. Such a discrepancy, if great enough, is likely to foster the development of an expectation of rejection and subsequent anxiety, especially in preadolescent boys. In the words of Kagan and Moss:

> "A boy's physical characteristics, therefore, make him susceptible to the acquisition of an anxiety-arousing self-concept and anticipation of social rejection, because of the association between an expectancy of peer rejection (by both boys and girls) and the absence of sex-appropriate physical attributes," (1962, p. 83).

Similar findings had been reported earlier by Secord and Jourard (1953) in a study with adults. They found low body cathexis to be associated with anxiety in the form of undue autistic concern with pain, disease, bodily injury, and feelings of insecurity.

There is also evidence (Head, 1920; Tait and Ascher, 1955; Gorman, 1969) that objective perception of somatic disturbance has a significant effect on both the body image and the body cathexis of adults. Furthermore, emphasis during the early years upon a particular body part as the result of disease or the attention of others creates an increased psychological value on that part which disturbs the body image (Bender, 1956). An earlier and more widely ranging survey of research on the somatopsychology of handicapping conditions (Barker, Wright, Meyerson, and Gonick, 1953) indicated strong relationships between disorders of physique, or disability, and behavior.

Hypotheses regarding the effects of somatic disorders on body image, body cathexis, and personality led to a series of studies investigating the subjective manifestations of these phenomena, using a variety of projective instruments. Fisher (1964) reported four studies designed to test whether there exists a relationship between the Rorschach barrier score and an index of exterior and interior body sensations among college undergraduates. Subjects were asked to report body sensations of which they were conscious under each of four different experimental conditions. Utilizing a nonparametric correlation technique Fisher reached the conclusion that the barrier score was linked to the relative prominence of exterior over interior body sensations. The higher the barrier score the greater the likelihood a subject would report

sensations from body boundary areas. However, Sherick (1965) using barrier and penetration scores along with other measures, found no association between body image concepts and location of psychosomatic symptoms in adults.

Fisher and Cleveland (1958) reported seven studies in which high barrier scores were found to be related to behavior, indicating tendencies toward self-steering, and little influence by outside events, in socialized ego-involving tasks. These studies were given additional weight by subsequent research by the authors cited and by others. For example, Fisher (1963) reported evidence that the more definite an individual's boundaries as defined by the barrier score, the more likely he is to perceive himself as possessing clear-cut identity and to have a concept of his body as a well differentiated sector of space connected with self. Fisher also stated that the high barrier score was positively correlated with greater ability to adjust adequately to disablement of one's body, to maintain normal ego integration, and to be effectively communicative in small group settings.

In another study in which college students served as subjects, Fisher (1964) noted a number of significant sex differences in body image. Again, the major instrument used was barrier-penetration scoring of Rorschach responses. Females were found to be more resistant to aneseikonic-induced perceptual changes in the leg area, had more definite knowledge of body boundaries, and were more concerned with body boundaries in the perceptual field than men. In other words, Fisher suggested that women have more clearly articulated and stable body concepts than men. This is in contrast to studies by Witkin in which the reverse relationship was found. It should be noted, however, that Witkin's research (which will be discussed later) involved measures which are more objective than the Rorschach.

Not all studies in which the Rorschach barrier and penetration scores are used have yielded conclusions which agree with those by Fisher. Mednick (1959) and Wylie (1961) both preferred to interpret barrier and penetration scores as indicative of cognitive or perceptual operations rather than concepts related to body experience. Fisher (1963) insisted that the relationships which have been found by him and his colleagues are too strong to dismiss, and that no dependable relationships have been found between boundary scores and indicators of cognitive or perceptual style. However, it also was found that Fisher (1965) later concluded body experiences and body schema do indeed intrude into cognitive processes among college students. In this study body awareness was found to be predictive of word recall, selective memory, and word production in an unstructured situation.

The question remains whether any firm conclusions can be reached from studies such as those reviewed above, with all data coming from application of clinical instruments and correlation of scores with subjective responses of subjects.

STUDIES WITH CHILDREN

Woods (1966) attempted to find some developmental relationships between children's body-image boundaries, estimates of dimensions of body space, and performance of selected gross motor tasks. She found that body-space dimensions and accuracy in estimating was greater with increasing levels of performance in gross body skills at each successive age level. Again, barrier scores on inkblots were used as a measure of body boundary definiteness.

In the only study found by the writer in which body image of normally-sighted preschool age children was explored (Katcher and Levin, 1955), an attempt was made to assess the reliability of an instrument in which subjects were asked to pick from three sets of gross body parts those individual parts which looked like Mother's, Father's, his own, and someone of the opposite sex. Some sex differences were noted (e.g. older girls in the sample, *CA* = 4-0 to 5-4, consistently perceived themselves as the smallest in the family group), and the measure was found to be generally reliable on a test-retest basis. The results

were also consistent with those of a previous study by the same authors done with older children, so it was concluded that the measure would be suitable for a longitudinal study.

Dyk and Witkin (1965), in a study with boys of urban middle class Jewish families, found strong relationships between the home atmosphere, the mother's body concept, and the child's body concept. They also found that boys with less differentiated body concepts tended to portray their fathers as nonsupportive.

From a review of the studies noted so far, it would appear that while much interest has been shown in relationships between body image and personality development, nearly all studies have been carried out with adults, using clinical measures with a high degree of subjectivity. Further research is needed to confirm or modify the conclusions of researchers like Woods (1966), who studied children and also attempted to relate clinical results to objective measures of body dimensions and performance in order to determine effective relationships between body image and other aspects of development.

BODY IMAGE AND PERCEPTUAL-MOTOR DEVELOPMENT

Although the theoretical literature contains many references to the probable relationship between body image and general perceptual-motor development, there appears to be a sort of understanding that a relationship exists, with little motivation to define the parameters of the relationship.

One of the most basic concepts in body image is known as articulation, the differentiation of the child and his environment, and eventually the differentiation of one part of his body from another. Linn (1955) referred to separation of the face from the hand-face-breast grouping as one of the earliest manifestations of articulation; then separation of the hand helps to further develop articulation.

Witkin (1965) has explored the body-environment articulation concept rather thoroughly with adults, and to a lesser extent with children. His conclusions were that each individual is self-consistent in body concept under a variety of conditions: that an individual with a more articulated body concept will be more independent of the perceptual field in which he finds himself than will an individual with a less articulated body concept. Witkin also has concluded that the ability to perceive one's body as segregated from the field is positively related to the ability to perceive any object as discreet from the organized context in which it is found. Wapner and Werner (1965) concluded that while articulation of body and environment is a requisite to perception of oneself or an object, for dynamic functioning within the environment, the organism in context is a more appropriate unit with which to deal.

Laterality, lateral preference, and the ability to discriminate right from left on one's own body and in the outside world, have been considered as important in cognitive development (Kephart, 1960). Research in this matter is hardly unequivocal, but it appears that there is no simple relationship between lateral preference and ability to discriminate right from left. In a study designed to explore the relationships between lateral dominance and right-left awareness, Belmont and Birch (1963) found that right-left discrimination which becomes stable in normal children by about age seven, predates consistent handedness by two years, and stabilization of eyedness and eye-hand preference by three years. Subjects for this study were 148 upper middle class elementary school children, with a mean IQ of 120.

Ayres (1965) studied relationships among the different kinds of sensory perception, motor activity, laterality, and selected areas of cognitive functioning. The modalities studied were vision, touch, and proprioception. Ayres found support for the argument that perception, particularly in the visual mode, grows out of motor activity. This is in agreement with Smith and Smith (1962) and Gibson (1966).

On the other hand, Abercrombie (1964) in a study comparing certain

body concepts, laterality, and perceptual-motor functioning in cerebral palsied (CP) and a non-cerebral palsied but equally physically limited control group (CG), found that the CP's, but not the CG's were impaired in visuomotor tests. Abercrombie also found no clear pattern of relationship with impairments on tests of somatic sensation and perception in the neurological examination, and impairment in psychological tests. Since both groups had been equal in the restrictions placed upon the amount of mobility, Abercrombie concluded that lack of motor experience alone could not account for the differences in motor performance. Certainly at this point it would seem that further research is in order to determine the extent to which additional motor experiences might modify perceptual-motor performance in children whose mobility has been limited.

ASSESSMENT OF BODY IMAGE

Several attempts at assessment of body image through performance tests have been made. The draw-a-man test, (Goodenough, 1926; Mackover, 1949) and its successors have been interpreted as means of assessment of body image, but the construct validity of this type of test as a measure of body image is a matter yet to be settled.

Certain sections of the Purdue Perceptual Motor Survey (Roach and Kephart, 1966) have been described by the authors as tests of body image. If one accepts the definition of the term as used in the present study (awareness of the body and its possibilities of performance, including a knowledge of body parts and their relative positions), these parts of the Purdue Survey would appear to be appropriate as at least part measures of body image. Similarly, for younger children the developmental scales of the Gesell Institute (Gesell and Amatruda, 1964), the Right and Left subscale of Ilg and Ames (1965), and the Bayley Scales (1935), would appear to have at least some face validity.

The Piagetian developmental constructs, motor behavior imitation and object concept, were used in one study with severely handicapped children (Guldager, 1970). Attempts have been made to use a clay-modeling analog of the drawing tests mentioned earlier, as a measure of body image with blind children (Swinn, 1967; Witkin, Birnbaum, Lomonaco, Lehr, and Herman, 1968). Cratty and Sams (1968) used a performance test involving verbal instructions and bodily movement with a group of blind children who ranged widely in age. Chase and Rapaport (1968) attempted use of a verbal adaptation of the Machover draw-a-person techniques with blind subjects.

STUDIES WITH BLIND PERSONS

Numerous studies have been carried out to assess the effects of artificially imposed sensory restrictions on the behavior of normal adults, with one of the major conclusions being that such restriction, especially deprivation of variation of stimulation, will produce gross disturbances of functioning in the areas of perception, cognition, and learning (Schultz, 1965).

BODY IMAGE, PERCEPTION, AND BLINDNESS

Research on the development of blind children has proven difficult because of the relatively low incidence of severe visual impairment among children, and the few reliable means of identifying them and assessing their behavior. In spite of advances in research with blind and partially-seeing children additional research continues to be needed in several areas (Tisdall, 1968).

The lack of vision as a source of stimulation to perceptual and cognitive development for the young child forces his reliance upon tactual, kinesthetic, and auditory impressions in developing a notion of space beyond the body. Further, lack of vision appears to result in early retardation in motor and adaptive behavior involved in adjustments to the physical environment, development of the concept of the permanence of objects, and the emergence of search behavior (Wilson and Halverson, 1947; Fraiberg, Siegel, and Gibson, 1966; Fraiberg, 1969). It should be noted that the three studies

just cited involved a total of only ten blind infants. However, especially in the case of Fraiberg (1969), a rigorous effort was made to locate subjects who were congenitally blind without serious concomitant handicaps. Therefore, the consistent finding of retarded development in perceptual-motor adaptive behavior among blind children implies that the absence of visual experience has a profound effect upon development of other perceptual systems.

In Fraiberg's (1969) study, as in the earlier, related study (Fraiberg, Siegel, and Gibson, 1966) search behavior, using tactile and auditory cues, did not begin until six or eight months of age, and even then occurred only if the child had immediately preceding manual tactile experience with the object. This was true even in cases where the object was a favorite toy emitting a distinctive sound. Search behavior on sound cue alone was not attained until after nine months for six out of eight subjects, and this behavior was a prerequisite to creeping in all eight.

Fraiberg's subjects showed ability to differentiate Mother from a stranger when being held at about six to eight months, and showed separation anxiety in Mother's absence for a longer time than sighted children. Fraiberg hypothesized (1969) that because the blind child's hands give him impoverished information about the world outside his own body, there is danger that in the early period of ego formation the personality may remain centered in body sensations and articulation. In Fraiberg's words, "the bridge between the body and an external world may be unstable or may not be found at all," (1969, p. 284).

That blind children differ from those with normal vision in their perception of the interrelationship with their environment appears to be sustained not only by the studies reviewed immediately above, but also by research with older children (Land and Vineberg, 1965).

Tactual-kinesthesis, although not the most efficient or possibly the most important of the spatial senses, is sometimes considered to be the best available after vision. Therefore, the tactual-kinesthetic sense is probably the dominant spatial sense in blind persons, with audition second (Fisher, 1964). A somewhat surprising outcome of Fisher's study was that the tactile sense was the dominant spatial sense for *both* blind and sighted subjects. One of the main problems with this study, however, was that the number of blind subjects participating was too small to permit very extensive generalization.

Worchel (1951) reported results of three studies in which congenitally blind, adventitiously blind, and sighted adults were compared on their ability in the areas of tactual form perception, spatial relations, and spatial orientation. Worchel concluded that his results favoring sighted over blind subjects and adventitiously blind over congenitally blind on all three measures were due to the availability of visual imagery to the sighted and adventitiously blind.

The seeming discrepancy between Worchel (1951), and Fisher (1964, cited above) might be explained by reference to J. J. Gibson's (1966) view of vision as a monitor and verifier of other perceptual interpretations, particularly those from tactual-kinesthesis. If this position were accepted, then vision or visual imagery could be accepted as an aid to accurate perceptions of space, without its necessarily being the primary or dominant perceptual mode even if it serves in a monitor role.

Furthermore, Gibson's (1966) and Smith and Smith's (1962) espousal of bodily movement as the key to perception, places the body image in a position of primary importance in the perceptual systems complex. Without vision as a verifier or monitor, the blind person has a difficult task, but if he has adequate knowledge and control of his body and its movement capability, he has the primary requisite for accurate spatial perception in many instances.

ORIENTATION IN SPACE

One group of studies was found in which the emphasis was on spatial

orientation and accurate movement without vision.

McReynolds and Worchel (1954) studied the ability of blind residential school students to orient themselves for near and distant places. Analysis of results showed no significant relationship between age at visual loss and performance in the orientation task. A major conclusion of this study was that visual imagery did not seem necessary for geographic orientation. Two frames of reference were used generally: direct experience for the State (Texas) and for nearby cities, and knowledge of maps for distant locations.

Cratty (1966) reported on a study in which normally-seeing college students were evaluated in their ability to make turns of 90, 180, and 360 degrees while in a state of visual deprivation. Individuals were found to be self-consistent in the degree of accuracy shown; in addition, there was an inverse relationship between accuracy and the distance the subject was required to move. The shorter distances (90 and 180 degrees) were fairly consistently overestimated, while the 360 degrees turn was underestimated.

Rouse and Worchel (1955), studying veering tendencies of blind subjects, found that the tendency to veer from a straight course was consistent in direction for individuals. Cratty (1967b) also studied veering tendency and perception of gradient in blind subjects. His conclusions were that veering was more dependent upon perceptual organization than upon objective measures of body structure. Furthermore, contrary to expectations, head torsion, leg length, hand and leg dominance were not predictive of direction or amount of veer.

Drever (1955) studied the ability of blind adolescents to perceive spatial relationships through the use of tactual-kinesthetic means, concluding that there was a generalized defect in space perception associated with early blindness. He hypothesized that this defect was due to the lack of appropriate tactile-kinesthetic experiences during early critical periods of development. Some support for this hypothesis is found in the study by Norris, Spaulding and Brodie (1957). Hunter (1960) also concluded that congenitally-blind subjects in his study had subtle but significant impairment in tactile-kinesthetic ability. Menaker (1967) interpreted inferiority of the performance of blind subjects on tactual-kinesthetic tasks as due to prolonged visual deficit.

Hartlage (1968), using a verbal test of spatial relationships, compared the performance of 50 congenitally blind and 50 seeing children matched on CA, sex, and achievement test scores. The author's overall conclusion from the study was that spatial ability was dependent upon exposure to some visual experience. However, the reported result that blind subjects, after large initial deficits, caught up with the sighted subjects and remained even with them thereafter, call the overall conclusion into question. The possibility exists that either the conclusion drawn from the study is not tenable, or the reliability of the instrument is questionable, or both.

In a project designed for preliminary standardization of a mobility scale for young blind children, Lord (1967) listed habitual movements in space, use of sensory cues in travel, and knowledge of directions and the ability to use this knowledge in making accurate turns, as major competencies related to performance in mobility tasks. All three of the above skills require accurate knowledge of one's own body and its capability of movement.

The cognitive patterning of congenitally totally-blind children was investigated by Witkin and his associates (Witkin, Birnbaum, Lomonaco, Lehr, and Herman, 1968) and first reported at the American Psychological Association Convention in 1965. The blind subjects in this study were found to be self-consistent in cognitive patterning, and as such supported Witkin's earlier hypothesis regarding cognitive style (Witkin, 1965). In addition, the Blind Ss in Witkin, et al. (1968), were found to be significantly inferior to a sighted control group in their articulation, including body concept, which was measured by

performance in the modeling of a human figure in clay. Swinn (1967), in a partial replication of the Witkin, et al. (1968) study, could not confirm Witkin's hypothesis that early visual loss is necessarily the obstacle to articulation development in blind children. Rather, in interpreting the results of his study of 108 congenitally and adventitiously-blind subjects, Swinn suggested that at least some vision must be present for an articulation style to be maintained at any age level. Salkin and May (1967), in a comparison of body image-ego development of deaf and blind children, found that blind children seemed to be quite disturbed in body boundaries and ego structure.

In addition to the studies cited above, several recent attempts have been made to assess body image in blind children. Chase and Rapaport (1968) investigated the possibility of using a verbal adaptation of the draw-a-person techniques of Mackover. Their subjects were 75 congenitally-blind children, CA 7-2 to 16-10, and 75 sighted children matched on sex, CA, and IQ. The authors found the technique to be reliable and suggested its possible use with blind subjects as a substitute for a drawing test. Further study with this technique is needed.

Guldager (1970) suggested an approach to evaluation of body image in severely handicapped rubella children, who are frequently found to be both severely visually impaired and hard of hearing. The author described an evaluation procedure based upon the Piagetian theories regarding imitation and object concept. While only four subjects were used in this study, Guldager concluded that this approach showed promise for diagnostic and programming purposes.

Study of performance in tasks involving movement, location and identification of body parts, and performance of tasks requiring knowledge of right and left has shown promise. Cratty and Sams (1968) carried out such a study with visually-impaired children in a special school in Los Angeles. The scale used was adapted from an earlier work of Cratty (1967a), in the area of perceptual-motor tasks, and consisted of 80 items, divided among five subscales: Body Planes, Body Parts, Body Movement, Laterality, and Directionality. Based upon the performance of 18 subjects, a test-retest reliability of 0.82 was obtained. The CA range for the 91 subjects in the study was 5 to 16 years, with a mean of 10.06 years.

The IQ range of the subjects was 57 to 144, with a mean of 88.32. IQ scores, which were obtained from school records, were available for only 59 of the 91 subjects. Use of the t-test for analysis of the data revealed significant differences between high and low IQ groups (with IQ = 80, as the dividing point) on Body Planes ($p < 0.05$), Body Parts ($p < 0.05$), Body Movement ($p < 0.01$), and Total Score ($p < 0.05$). Although there were no significant differences on the Laterality and Directionality subscales, the higher IQ group's scores were superior to those of the lower IQ group on both. Significant differences in performance between totally blind and partially seeing subjects, in favor of the totals, were found on the Body Planes, Body Parts, Laterality, Directionality, and Total Score ($p < 0.01$ on each). No significant sex differences were reported.

Questions were raised by the authors regarding relationships between body image as measured by the scale and both degree of vision and IQ because of possible differences of the subjects in this study from the general population of blind children. One might also raise the question of a possible interaction between level of vision and IQ as a possible contributor to the differences noted.

Finally, Cratty and Sams also suggested use of the scale as a diagnostic tool, and recommended a possible approach to body-image training for blind children, using the general outline of the scale as a guide.

BODY IMAGE AND COGNITIVE DEVELOPMENT

There is a considerable volume of theory to suggest that body image is related to cognitive development (Kephart, 1960; Dunsing, 1966; Barsch, 1967). Kolb (1959),

suggested that the postural model of the body (body image) as described by Head (1920) was related to intricate motor activities which are so important to the blind child for acquisition of information about the environment. The postural model in turn is defined by the early kinesthetic and tactile experiences of the child. It has been hypothesized that until the child has a coordinated and coherent understanding of the body image, learning in the form of reading and number concepts will either not take place or will be severely retarded (Cruickshank, 1965, p. 318).

A study designed to identify tests which could be used to predict ability to learn reading and related skills revealed several perceptual-motor tests, performance on which successfully predicted reading performance. Among those which were found to be predictors were human figure drawing, pegboard speed, and the Bender Gestalt (de Hirsch, Jansky, and Langford, 1966). Decreased variation in the sensory environment has been found to have detrimental effects on the cognitive functioning of normal adults (Bexton, Heron, and Scott, 1954). Furthermore, there is evidence to suggest that early sensory deprivation prevents formation of adequate models and strategies for dealing with the environment (Bruner, 1961), and that blindness in particular is related to generally poor motor performance in school-age children (Bourgeault, 1964). Adkins (1965) found that blind and partially blind children were retarded in classification concepts based upon performance on sorting tasks which required tactile and kinesthetic discrimination. It was hypothesized by the author that early sensory deprivation results in inadequate development of the neural network fundamental to this type of cognitive functioning.

It seems apparent that much interest and information exists in the general area of body image. Studies relating body image, body concept, and personality development have yielded some generalizations upon which hypotheses for future research could be based. However, since most of this research is retrospective in nature and employs largely subjective measures, it leaves open many questions about the validity of the conclusions, and possible additional or alternative significant factors. In addition, nearly all of the body image-personality research has been carried out with adults, and developmental aspects related to children have been inferred. It remains to be seen whether similar results could be obtained with children, and whether behavioral correlates exist.

Although some of the research into possible connections between perceptual-motor development and cognitive development shows promise, assumptions of increased intellectual capacity due to programs of perceptual-motor training would appear to be premature.

The most fruitful area of inquiry over the past several years appears to have been approaches to the question of whether training can affect changes in the way a man perceives his environment (Gibson and Gibson, 1955). Behaviorally oriented measures are available to test some aspects of this question, and some positive results have been recorded (Thorndike, 1932; Gibson, 1953; Painter, 1966; Hill, McCullum, and Sceau, 1967; Johnson and Fritz, 1967; Benyon, 1968).

PRINCIPLES OF TRAINING PROGRAMS

Movement. Movement appears to be the key to perceptual-motor development and perception of space (Head, 1920; Schilder, 1950; Smith and Smith, 1962; Gibson, 1966; Gorman, 1969). This applies equally, or perhaps to an even greater extent, when one considers perceptual-motor development in blind persons. Without vision, space must be experienced and conceptualized haptically. Therefore, body image is more than a visual picture of the physical body for a blind person; it is a dynamic concept which includes knowledge of the space occupied by the body, and its potential for movement and physical interaction with the environment (Revesz, 1950; Van Weelden, 1967).

Early Learning. Many basic perceptual skills must be learned early. There is some evidence that

the critical period concept (Hebb, 1958) may apply in motor learning with particular appropriateness for blind children (Drever, 1955; Norris, Spaulding and Brodie, 1957; Halliday, 1970).

Body-Image Development in Blind Children. Few studies have been undertaken to evaluate the effectiveness of training on body-image development in young blind children. However, studies with young mentally-retarded children (Hill, McCullum, and Sceau, 1967; Daw, 1964; Benyon, 1968), and with normal kindergarten children (Painter, 1966; Ball and Edgar, 1967) have produced encouraging results. All of the studies cited immediately above have involved use of Kephart-type training programs, with primary emphasis on development of balance, locomotion skills, body awareness, right and left exercises, and in some cases, ocular-motor exercises (Kephart, 1960).

Numerous writers have suggested principles and activities for the development of movement skills for young blind children (Lowenfeld, 1950; Revesz, 1950; Drever, 1955; Norris, Spaulding, and Brodie, 1957; Fields, 1964; Parmalee, 1966; Salkin and May, 1967; Cratty, 1967b). However, most suggestions were either advanced after a more or less thorough review of existing literature, or as implications at the end of a descriptive study. Very few studies have been attempted which even suggested a format that might be subjected to evaluation. No research at all was found in which a systematic program of body-image training was proposed and then evaluated in a controlled experiment.

Cratty (1967a) suggested a rationale and program for teaching perceptual-motor tasks to mentally-retarded and neurologically-handicapped children. This moderately structured program also contained teaching suggestions, including tips on motivation, avoidance of negative consequences of failure (e.g., discouragement, injury, and social punishment) and distributed practice. Cratty emphasized direct teaching of the desired skills, learning by doing, and teaching to the areas of weakness.

Cratty's publication, mentioned above, was the source of the scale which eventually was developed and utilized in a study of body image in blind children (Cratty and Sams, 1968). One of the outcomes of this study was a series of suggestions for a program of body-image training for blind children.

Guldager (1970), suggested activities which might be effective in body-image training of severely-handicapped rubella children. Her program was based upon individual evaluations of four children through use of Piagetian theory. Hill (1970) reported significant gains in concepts related to body position in space among 15 congenitally-blind children aged 7 to 9 years following a three-month training program.

These studies have yielded useful data regarding the level of body-image development in young blind children, and suggestions for training programs. However, the Cratty and Sams data suggest that training in body image would ordinarily be most important for children of kindergarten or preschool age. This view is reinforced when one glances at developmental sequences and skills expected in children of these age groups (Ilg and Ames, 1965). Guldager's work appears to have promise for the severely-handicapped young child, and will bear consideration for future research.

Body Image and School Readiness in the Young Blind Child. Halliday (1970), intellectually "standing on the shoulders" of her predecessors, has defined a sequence of development for the young preschool-age blind child, with behavioral goals, suitable activities for every phase of development, and a list of educational materials to accompany the program. While some very worthwhile general suggestions have been made for the development of body articulation, laterality, and movement skills, a specific program is needed to fill out the outline Halliday has proposed.

One of the recommendations which emerged from the Louisville Conference of Teachers of Visually Handicapped Children in Tennessee

(1968) was that a take-apart doll be produced by the American Printing House for the Blind, as an aid to be used in teaching body parts to blind children. The question of whether a replica of reduced size can be an effective aid to learning relationships is largely unanswered at present. Halliday (1970) mentioned, in regard to the use of models, that a young blind child ordinarily should have extensive experience with the real object before a model of it will have meaning. The question is whether learning on a small pattern or model will have a positive effect on performance on a larger pattern. Cratty (1962) studied the effects, in adults, of practice on a small stylus maze upon their ability to traverse a large loco-motor maze. His conclusion was that some transfer occurred, but that it was apparently a phenomenon which occurred below the level of consciousness. No further research in this particular area has been found, and no similar research with children has been carried out, to the knowledge of the writer.

Walker, utilizing some of Halliday's principal suggestions, and relying rather heavily also on the structures proposed by Cratty (1967a), developed a structured program of body-image training, to be applied with blind children nine years of age and younger (Walker, 1970). The program consisted of 14 individual, 10-minute lessons, and was evaluated in a pilot study. A wooden, take-apart doll, provided by the American Printing House for the Blind, was utilized with the individual lessons. The Cratty and Sams (1968) Body Image Screening Test (BIST) was used as a criterion measure.

While the children who received the training appeared to improve in overall body-image skills, the results were equivocal due to the limited range of the BIST, the small sample (N = 26), and the wide range of *MA*, *CA*, and Visual Acuity (*VA*).

In a subsequent study, with the above variables more carefully controlled, Walker, 1971) found that a short term, highly structured series of lessons was effective in improving the body image of kindergarten-age blind children. Furthermore, the program produced greater gains when used with children without useful vision, whose general intellectual levels were below average. A wooden, dissectable doll was used in the study, but its value as a teaching aid could not be assessed empirically within the limitations of the study.

SUMMARY

The body of literature in theories related to body image reveals two basic positions: the Freudian, which might be referred to as a *subconscious* theory, and a *sensory-motor* theory. The latter deals primarily with the physical dimensions of the body and its parts, the location of body parts, and the body's capability of movement. Although there are studies dealing with both objective and subjective concepts of the body, most research has related to these concepts in the conscious, physical domain.

In theory, body movement, and the sensory input resulting therefrom, is considered to be a basic component of perceptual development. As movement efficiency increases, differentiation of environmental stimuli improves, enhancing and enriching concept development. At the heart of this developmental domain is the body as the reference point for all environmental experiences. Consequently, an accurate concept of his physical self is crucial to the young child's perceptual development.

With young visually-impaired children, body image may also be significantly related to general intellectual development. It is hypothesized that lack of vision in a very young child shows the development of articulation of the physical self and the environment, resulting in retardation in development of perceptual-motor skills and concepts.

It has been demonstrated that intervention by way of a highly structured training program aimed specifically at body image development is effective with young, visually-impaired children. However, further research is needed to verify results and to refine the techniques. While some empirical evidence of improvement due to training has been

found, specific elements of the body image learning process need more careful definition. For example, it needs to be determined whether models (dolls and manikins) contribute significantly to the learning of body parts, laterality, directionality, and body movement, and whether it is advantageous for these devices to be dissectable. The question of the most effective sequential arrangement of the training activities needs investigation. Developmental theory indicates that differentiation normally proceeds from the general to the specific. It has generally been assumed that this sequence would apply to visually-impaired children as well as to sighted children. However, there appears to be some logic in the alternate hypothesis that without vision as a monitor perception via the haptic system may proceed in the opposite way, from the specific, through a sequential integrative process, to the general. Additional research is needed to clarify this process so that training programs can be organized for more effective learning.

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A STUDY OF LEISURE TIME ACTIVITIES OF SCHOOL STUDENTS*

Valdemar Paske
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METHODOLOGY

A total of 78 students from a municipal school in the metropolitan area, the State Institute for the Blind, and the State Morning School for the Deaf in Copenhagen, made daily entries on a questionnaire, from Monday through Sunday, about their leisure time activities, entered every half hour upon arriving from school until bedtime. Before filling out the questionnaires, the students received instructions from a teacher or from someone outside of the school. Each student also received a student card with a number which was entered on each day's questionnaire. The student card also asked questions about the employment of the student's father and/or mother, and ". . . what he wanted to be when he grew up."

The students were told that their names would not appear on the questionnaires so that they need not fear reactions from their teachers on the answers they gave.

The questionnaires were collected from the students each day and mailed to an address and person who had no connection with the schools.

Student participation in the three schools was as follows:

School	Boys	Girls	Total
Municipal School	11	23	34
School for the Blind	12	18	30*
School for the Deaf	7	7	14
Total	30	48	78

*School for the Blind: 4 boys and 11 girls who were braille readers; 8 boys and 7 girls who were inkprint readers.

This study does not claim representativeness of municipal schools, only of the blind and deaf in all 8th and 9th grade classes of the Copenhagen schools.

Every student's daily questionnaire was coded into 25 different leisure-time categories and punched into IBM cards. We also made up a summary card for a single activity for the entire seven-day period. In this paper we will discuss only the summary card, because the differences in the single day's activities were not significant.

The questionnaire was filled out in half-hour intervals. Each point reflects one half-hour performance. For example, one student's questionnaire showed that in seven days he used 1-1/2, 1-1/2, 2, 3, 4, 1, and 6 points for meals; this was entered on his summary card as a score of 19 for meals. The same student might have used 41 points (or 20-1/2 hours) on active sports during the same week. For each school the points scored by all students for each of the 25 major activities were totaled. Taking the grand total of leisure time for all students as 100, the percentage of time spent on each activity was calculated. It should also be mentioned

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*This research was done in March-April 1965. All comments are our own. Acknowledgement and thanks are due to the head masters, teachers, students, and H. C. Seierup who made this research possible.

**Roskilde Hojskole, Copenhagen.

TABLE 1

Meals and Household Chores

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Meals	11.1	10.5	10.7	10.4	12.8	11.8	15.7	14.4	15.1
Household Chores	4.1	8.0	6.9	3.5	6.0	4.9	7.9	12.2	10.1
Total	15.2	18.5	17.6	13.9	18.8	16.7	23.6	26.6	25.2

that one percent equals about five minutes activity.

The School for the Deaf students used more time for meals than the other two groups who show almost an equal amount of time spent on this activity. It may be that the more isolated deaf students use meals as a means of communication and their mode of language would make meal times longer.

As anticipated, the girls used more time for household chores; but the boys made higher scores than was expected. The School for the Deaf students scored highest of the schools. The School for the Blind students scored lowest, but only because they live in a boarding school where they have practically no need to do housework.

Scores shown for playing a musical instrument--we call this "active"--show no great differences; the percentages are greater for the girls. Perhaps we could have expected the blind students to have participated more in active music. As expected, there was no score for the School for the Deaf.

The percentages for listening to radio and TV are much larger. It is worth mentioning that the boys from the municipal school used about one-fifth of their leisure time for this activity. The totals show no great differences. The students' scores from the School for the Deaf must mainly be derived from TV watching because these students could not listen to radio.

TABLE 2

Playing Musical Instruments, Listening to Radio and TV, Listening to Records and Tapes

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Playing Musical Instruments	1.2	2.5	2.2	1.9	2.5	2.1	-	-	-
Listening to Radio and TV	20.6	12.2	14.5	9.1	14.4	12.3	13.1	12.0	12.6
Listening to Records and Tapes	2.1	1.5	1.7	6.1	6.3	6.2	-	-	-
Total	22.7	13.7	16.2	15.2	20.7	18.5	13.1	12.0	12.6

Listening to records and tapes show the biggest differences. The municipal school students show three to four times less time spent on this activity. It is necessary to remember that the students from the School for the Blind all have tape recorders, and even if they do not indicate greater involvement in active music, we must still believe that they have a greater interest in music. The students from the School for the Deaf are, of course, not represented in this activity.

Examining the total time spent on listening to radio and TV, records and tapes, one notes that the students from the School for the Blind spent the largest amount of time on these activities; 18.5 percent of their leisure time. In the municipal school, it was the boys who showed the largest percentage, but in the School for the Blind the girls used the most time for this activity.

No difference has been made between homework and reading for pleasure. As mentioned above this study was made of students from the 8th and 9th grades who are usually not required to do much homework. For the blind students the time spent for listening to tapes was consistent. In all three groups the boys used more time than the girls. The students from the municipal school read more than those from the School for the Blind, who, again read more than the students from the School for the Deaf.

The limited choice in literature for the blind and the more difficult reading mode for the blind, braille, might be one explanation. It is not surprising that the group of deaf students, with their several difficulties, showed the lowest score.

TABLE 3

Reading for Pleasure and Homework

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Reading for Pleasure and Homework	10.3	7.5	8.3	9.4	6.7	7.8	8.0	5.1	6.5

TABLE 4

Sports, Games, etc.

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Active Sports and Scouting	8.3	2.0	3.8	0.5	0.6	0.6	8.4	1.8	5.1
Passive Sports	-	0.1	0.1	-	-	-	3.3	-	1.5
Playing Games (ball, air gun shooting, etc.)	2.4	3.1	2.9	0.3	0.1	0.2	5.3	0.3	2.7
Card Games	2.0	-	0.6	0.8	0.5	0.6	0.8	2.2	1.5
Hobbies (stamp collecting, model building, etc.)	1.2	-	0.4	2.4	-	1.0	1.2	0.1	0.6
Knitting, Handwork, etc.	1.2	0.2	0.4	2.9	2.9	2.9	0.7	7.7	4.2
Total	15.1	5.4	8.2	6.9	4.1	5.3	19.7	12.1	15.6

Among the students from the School for the Deaf there is a very active working Scout group which brings this group's scores up very high. Altogether the boys are much more active in sports than the girls. Very low totals for the blind students are a result, perhaps, of the limitations of the handicap, but this does not necessarily have to be so, because there are other possibilities which the blind can use to advantage.

The time used for passive sports --following games as a spectator--is surprising, but might be explained by the fact that this need can be solved through television and radio.

For playing games, we assessed all the favorite games of the children of Denmark (not including football, which is considered under active sports). Playing games mean a lot to the students from the municipal school, especially for the girls, but also for deaf boys. Why don't deaf girls and children from the School for the Blind play them? Possibly because the 8th and 9th grade of the School for the Blind had just enrolled in the Copenhagen school, after transferral from the Kalundborg school, and the students had been separated from younger colleagues with whom they had played, but were reunited with their older friends, who had moved to the Copenhagen school one or two years earlier. There might also be fewer possibilities to play in Copenhagen, but we don't think this is the whole explanation because the existing possibilities are not fully used.

We define the terms used as follows:

Friends--same age group, peers, colleagues from school, etc.;

Adults--adult friends, adults visiting with the family, etc.

The blind and the deaf had more visits. Yet it must be remembered that most of these students live at school, and visits include visits to their rooms by colleagues. In all three groups it is the girls who had

TABLE 5

Indoor Activities with Friends

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Entertaining Friends	0.5	1.7	1.4	1.0	6.5	4.3	0.7	2.7	1.7
Visiting Friends	4.2	9.5	8.0	8.3	5.0	6.4	0.1	6.2	3.2
Total	4.7	11.2	9.4	9.3	11.5	10.7	0.8	8.9	4.9
Entertaining Adults	-	1.7	1.2	-	-	-	1.2	1.0	1.1
Visiting Adults	-	4.6	3.3	6.2	4.3	5.2	1.2	0.5	0.8
Total	-	6.3	4.5	6.2	4.3	5.2	2.4	1.5	1.9
Secondary Contact	-	0.3	0.2	1.4	0.7	1.0	0.4	0.8	0.6
Total (5 Activities)	4.7	17.8	14.1	16.9	16.5	16.9	3.6	11.2	7.4

the most visits, especially the girls at the School for the Blind.

The girls would appear to be the more social. Among the blind students, the boys used 8.3 percent of their leisure time to visit friends, while the girls used only 5 percent, which might mean that some of the boys visited the girls at the school. The total amount of contact with friends shows no large differences between the municipal school and the School for the Blind. Here again the deaf students' problems in social life show up in contact with friends, which is only about half as often as that among other groups.

None of the students had many visits from adults, neither relatives nor friends. The students from the School for the Blind spent no time on this activity.

Visiting adults is not frequent among students in the municipal school and the School for the Blind; students from the School for the Deaf showed even lower percentages, which one might interpret as characteristic of their social contact problems.

If we look at the total time spent in contacts with adults, the municipal school and the School for the Blind students spent about five percent of their leisure time on this activity while the School for the Deaf students used only two percent.

Secondary contacts--telephone calls, letter writing, etc.--show the least amount of time spent among students from the municipal school. The explanation surely is a simple one. Both blind and deaf students live at school and therefore have a greater need for this kind of contact.

If we look at the totals for all contacts with adults we see that students from the municipal school and from the School for the Blind spent almost the same amount of time in this activity, but the time spent by School for the Deaf students is less than half of the others. It might also be mentioned that time spent on this activity by the boys and the girls from the School for the Blind is about equal.

The boys from the municipal school and the School for the Deaf used about one-third as much of their time on the total scores for indoor activities as other students.

Table 6 showed the biggest differences among the three groups of students. The blind and deaf spent much more time loafing and wasting time than the students from the municipal school. The boys from the School for the Blind wasted the most amount of time--about one-sixth of their leisure time. In the municipal school and the School for the Deaf it was the girls who wasted the most time.

Table 7 showed the girls from the municipal school spent the greatest amount of time working, mainly baby sitting. A couple of boys from the School for the Deaf had jobs which influenced the figures shown.

Table 8 showed the percentages for the municipal school and the School for the Deaf are almost the same, and show no significant differences according to sex. The boys from the School for the Blind used only half as much time for this activity as the girls.

TABLE 6

Loafing, Wasting Time, Sleeping beyond the Normal Time

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Loafing, etc.	1.4	3.0	2.6	17.4	9.5	12.7	3.9	5.4	4.7

TABLE 7

Work (Paying Jobs)

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Work (baby sitting, washing cars, etc.)	1.4	5.1	4.0	0.4	0.2	0.2	1.8	--	0.9

TABLE 8

Travel

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Travel (walks, including preparation)	15.2	15.5	15.3	6.6	11.1	9.3	15.2	13.3	14.3

TABLE 9

Social Activities, Extra Curricular Studies

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Social, Clubs	1.3	1.3	1.3	2.2	-	0.9	2.6	0.5	1.6
Extracurricular Studies	2.2	1.5	1.7	-	-	-	-	-	-
Cinema, Theatre, Museum	5.2	1.7	2.7	0.5	0.5	0.5	0.5	1.3	0.9
Dances, Parties	3.0	6.3	5.4	8.7	9.3	9.1	7.6	12.2	10.0
Total	11.7	10.8	11.1	11.4	9.8	10.5	10.7	14.0	12.5

TABLE 10

Other

	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Other (medical, etc.)	1.0	0.2	0.4	-	0.1	-	0.4	0.3	0.3

The total percentages for all these activities showed only slight differences from group to group.

Social activities played a bigger role for the boys from the School for the Blind and the School for the Deaf. There was no large difference between the boys and the girls from the municipal school in this activity.

Extracurricular studies are not offered by the School for the Blind or the School for the Deaf; it was mostly the boys from the municipal school who spent time on this activity.

The percentages for visiting museums, etc., are very small. For the municipal school visiting the cinema played the biggest role. As expected, the cinema has only slight interest for students from the School for the Blind; but it was expected that the deaf would use the cinema more than they did.

All three groups had dances arranged for the week sampled, which explains the high percentages for this activity.

On the first day during the questionnaire period the students were asked if they knew what they wanted to do after leaving school. The table shows, as expected, that the boys knew more about what they wanted to be than the girls. The municipal school shows that most of the students had plans for their future: 27 students, or four-fifths of the total. About half of the students from the School for the Blind had their occupational plans formed--about the same number as from the School for the Deaf. It should be mentioned that none among the three groups mentioned occupations that would be impossible because of an individual's handicap.

TABLE 11

Occupation Questionnaire

Do you know what you want to be when you grow up?

	Boys		Girls	
	Yes	No	Yes	No
Municipal School	10	1	17	6
School for the Blind	8	4	9	9
School for the Deaf	5	2	3	4
Total	23	7	29	19

TABLE 12

Percentages for Each School on Each of the 25 Leisure Time Activities

Leisure Time Activities	Municipal School			School for the Blind			School for the Deaf		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Meals	11.1	10.5	10.7	10.4	12.8	11.8	15.7	14.4	15.1
Household Chores	4.1	8.0	6.9	3.5	6.0	4.9	7.9	12.2	10.1
Playing Musical Instruments	1.2	2.5	2.2	1.9	2.5	2.1	-	-	-
Listening to Radio and TV	20.6	12.2	14.5	9.1	14.4	12.3	13.1	12.0	12.6
Listening to Records and Tapes	2.1	1.5	1.7	6.1	6.3	6.2	-	-	-
Reading for Pleasure and Homework	10.3	7.5	8.3	9.4	6.7	7.8	8.0	5.1	6.5
Active Sports and Scouting	8.3	2.0	3.8	0.5	0.6	0.6	8.4	1.8	5.1
Passive Sports (spectator)	-	0.1	0.1	-	-	-	3.3	-	1.5
Playing Games	2.4	3.1	2.9	0.3	0.1	0.2	5.3	0.3	2.7
Card Games	2.0	-	0.6	0.8	0.5	0.6	0.8	2.2	1.5
Hobbies (stamp collecting, etc.)	1.2	-	0.4	2.4	-	1.0	1.2	0.1	0.6
Knitting, Handwork, etc.	1.2	0.2	0.4	2.9	2.9	2.9	0.7	7.7	4.2
Loafing, Wasting Time	1.4	3.0	2.6	17.4	9.5	12.7	3.9	5.4	4.7
Entertaining Friends	0.5	1.7	1.4	1.0	6.5	4.3	0.7	2.7	1.7
Visiting Friends	4.2	9.5	8.0	8.3	5.0	6.4	0.1	6.2	3.2
Entertaining Adults	-	1.7	1.2	-	-	-	1.2	1.0	1.1
Visiting Adults	-	4.6	3.3	6.2	4.3	5.2	1.2	0.5	0.8
Letterwriting, Telephoning	-	0.3	0.2	1.4	0.7	1.0	0.4	0.8	0.6
Work (paying jobs)	1.4	5.1	4.0	0.4	0.2	0.2	1.8	-	0.9
Travel (including preparation)	15.2	15.5	15.3	6.6	11.1	9.3	15.2	13.3	14.3
Clubs and Social Activities	1.3	1.3	1.3	2.2	-	0.9	2.6	0.5	1.6
Extracurricular Studies	2.2	1.5	1.7	-	-	-	-	-	-
Cinema, Theatre, Museum	5.2	1.7	2.7	0.5	0.5	0.5	0.5	1.3	0.9
Dances, Parties	3.0	6.3	5.4	8.7	9.3	9.1	7.6	12.2	10.0
Other (medical visits, etc.)	1.0	0.2	0.4	-	0.1	-	0.4	0.3	0.3
Total Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Hours of Leisure Time	521	1304	1825	669	977	1646	380	390	770
Daily Mean for Each Student[1]	7.1	8.3	7.9	8.0	7.8	7.8	7.8	8.0	7.9

[1] Less days of illness.

THE EFFECT OF LATERAL POSTURAL BALANCING ON GAIT PATTERNS OF BLIND SUBJECTS*

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INTRODUCTION

The study was conducted over a two-year period initiating a pilot study in 1969-70 and repeated the second year, 1970-71. During the second year identical study procedures were utilized to retest the pilot study hypothesis that veering tendencies could be reduced as a result of postural balancing. It was not anticipated that immediate correction of veering patterns would be accomplished but would result from reorientation of the posturing mechanisms after a period of time by daily wearing of the shoes equipped with the corrective heel lift.

When lateral tilting of the pelvis is present specific lateral deviations take place in the spinal column as well as the neck and head to maintain the upright posture. The simplest form would be a single curve of the spine to the low side of the pelvis with a torque of the spine to the opposite or high pelvis side. This torque mechanism would rotate the shoulder on the high pelvis side slightly backward. The neck would then rotate in the opposite direction as the head moved into a position to remain in a perpendicular position for visual balance. All of these adjustments are necessary for the maintaining of the center of gravity over the feet. "In the sighted, visual coordination plays a major role in the adjustment process." While in the nonsighted, ". . . the semicircular canals and the proprioceptive and kinetic sense of the muscular and joints subserve this function entirely."[2]

In this state of lateral postural imbalance an incorrect concept of correct balance may unknowingly be developed by the blind person. With the lateral tilting of the pelvis present, the short-leg syndrome, gait-pattern anomaly also exists which may be accountable for an asymmetrical-movement pattern of veering to the short-leg side.[3] Although this concept would seem logical as a hypothesis, Harris[4] pointed to the work of Schaeffer in which he found that "different sizes and directions of spirals were noted in many subjects, but they did not seem to correspond to such factors as leg length or hand dominance." The pilot study of Klein et al.[5]

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also found that veering to the short-leg side on initial tests could not be predicted.

The existence of lateral deviations, short-leg syndrome of the skeletal system are found to exist with high incidence in various populations studied. Pierson, et al.[6] utilized standing x-ray as a measurement technique for determining lateral asymmetry/ 831 students were measured every two years during their progress through school. In the group 93.7 percent were evaluated to show evidence of lateral asymmetry. Another standing measurement survey study[7] of 585 elementary, junior, and senior high school boys indicated that lateral asymmetry existed in a high percentage of the population and that the problem was progressive. The study reported that 74, 85, and 92 percent of each of the groups studied showed evidence of measurable lateral asymmetries respectively. While common lateral postural asymmetries are reported to exist in the sighted, they are also present in the blind with approximately the same incidence.

DESCRIPTION OF SUBJECTS

During the two years of this study 125 students from the Texas School for the Blind in Austin were measured for lateral posture asymmetry. This was based on lateral tipping of the pelvis (posterior iliac spines) and classified as the short-leg syndrome. Of the group 85 were boys ranging in age from 9 to 19 years, mean age was 15.58 years; and 40 girls, 9 to 19 years with a mean age of 15.54 years.

MEASUREMENT TECHNIQUES

LATERAL POSTURAL MEASUREMENT

Standing lateral postural measurements were administered by palpation of the posterior iliac spines to determine the lateral tipping of the pelvis, the general curvature of the spine, and the position of the shoulders. Calibrated blocks were inserted beneath the heel of the foot on the side of the low posterior iliac spine to level it with the high side.[8] The Adam's test (forward bending) was administered before and after pelvic leveling to determine the functional and/or structural status of the lateral curvature.

Measurement Findings. The boys range of lateral asymmetry was 1/4" (6.5mm) to 3/4" (19.5mm); 49 were low on the left side and 24 on the right side. The girls range was 1/8" (3mm) to 3/4" (19.5mm); 20 were low on the left side and 12 on the right side.

Auditory screening test data for possible hearing-loss influence on veering tendencies was recorded.

WALKING COURSE AND MEASUREMENT PROCEDURE

The same walking course was used for the two years of the study (Figure 1). The course was 150 feet long and 40 feet wide on a macadam surface. The length was marked off in 10-foot intervals and the width in 2-foot intervals from the center line. A 2' x 6' x 2' board was

Measurement Findings

	Measured	Lateral Asymmetry	Pelvis Level	No Measure
Boys	85	73	9	3
Girls	40	32	8	0
	125	105 (84%)	17 (13.6%)	3 (2.4%)

Figure 1. Tracking Course for Testing of Veering Tendencies

secured to the surface at the south end of the course at 0 feet and at a right angle to the center line. No attempt was made to control the external environment. Rouse and Worchel[9] in their studies concluded, ". . . that since veering tendency does exist, blind individuals probably need auditory or tactile cues signifying straightness in order to walk a straight line." Our intent was to make this test in a normal space environmental situation.

Record cards were prepared on 5" x 8" cards similar to the course for recording initial and final walking pattern data for all subjects selected for the experimental and control groups.

Pretest measures for straight line and veering were administered to the selected groups while they were wearing their regular shoes. The subject was placed in a position with heels against the starting block facing directly down the center of the course. Instructions were to walk at their normal speed and a command would be given to stop when the other end or a side curb was reached. As the subject walked the course, he was followed and the pattern of movement plotted on the record card.

SELECTION OF EXPERIMENTAL AND CONTROL GROUPS

Subjects were selected for both groups on the basis of the amount of lateral pelvic asymmetry as determined by the postural measurement phase of the program.

Experimental Subjects (39). Subjects were selected if they met the following criteria:

1. A lateral tipping of the pelvis, "short-leg syndrome," as judged by the imbalance of the posterior iliac spines, with the low shoulder or the high side of the high iliac spine and general spinal curvature to the low side.

2. If in the Adam's test the high side of the back was on the high iliac spine side (showing the spinal torque).

3. When the calibrated blocks were used to level the posterior iliac spines, the spinal column was derotated to a level position in the Adam's test. For the 39 experimental subjects selected the mean age was 15.71, range 9 to 19 years. The mean lateral imbalance was 8.75mm, range 1/4" (6.5mm) to 3/4" (19.5mm).

These subjects were measured for regular shoes by a contractor in Austin, Texas. A heel lift was applied to the heel of the shoe on the low posterior iliac spine side according to the measured imbalance determined by the posture tests. For those subjects with over 1/2" imbalance an addition was also placed on the sole of the shoe to eliminate the amount of plantar foot drop produced by the heel lift.

The one basic difference between the subjects of the pilot and second-year study is that the mean age level for both groups increased: experimental 1.73 years and control 2.7 years.

Control Subjects (37). These subjects were selected on the basis of similarity of lateral pelvic imbalance as was the experimental group. The mean age was 15.22, range 9 to 19 years. The mean lateral imbalance was 9.25mm, range 1/4" (6.5mm) to 3/4" (19.5mm).

EXPERIMENTAL PROCEDURES

Following the initial postural and tracking tests the experimental subjects were given their shoes with the heel-lift correction and requested to wear them at least six days per week for the remainder of the *experimental period*. This period extended over three months. The shoes were frequently checked for wear and need for repair. The members of the school physical education staff and dormitory mothers assisted in the procedures.

At the end of the experimental period, posture and tracking tests were readministered to both groups by identical procedures as in the initial tests. The experimental subjects were tested with the corrected shoes.

STUDY FINDINGS

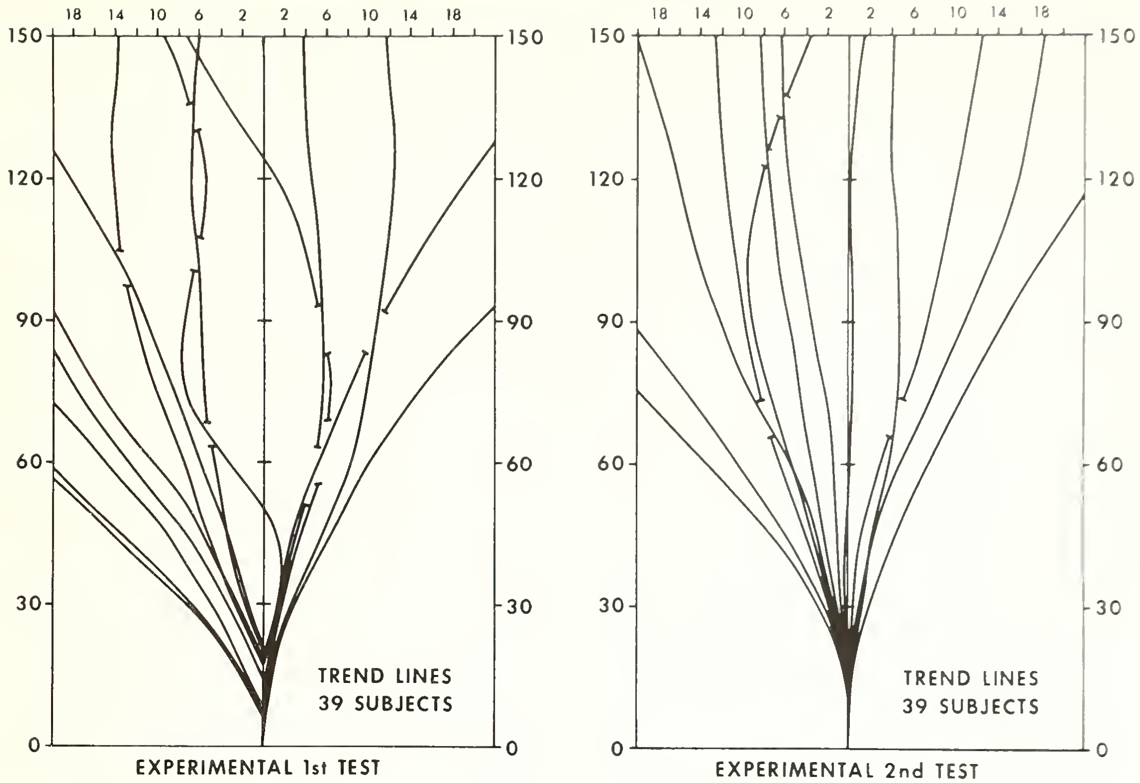
Experimental Subjects (39). Four of the six younger subjects, 9 to 14 years, corrected to lateral pelvic symmetry. Seven showed evidence of partial lateral postural correction. Twenty-six of the older subjects did not change.

The percentage of subjects showing corrected lateral postural imbalance was similar to the findings of the elementary school studies by Klein and Buckley.[8] The lack of postural correction for the older subjects was possibly due to the fact that structural growth was more complete.

On the second test: 23 (59 percent) of the subjects improved in their straight-line tracking, 10 (25.6 percent) showed little change in their tracking ability, and 6 (15.4 percent) subjects appeared to be more deviant.

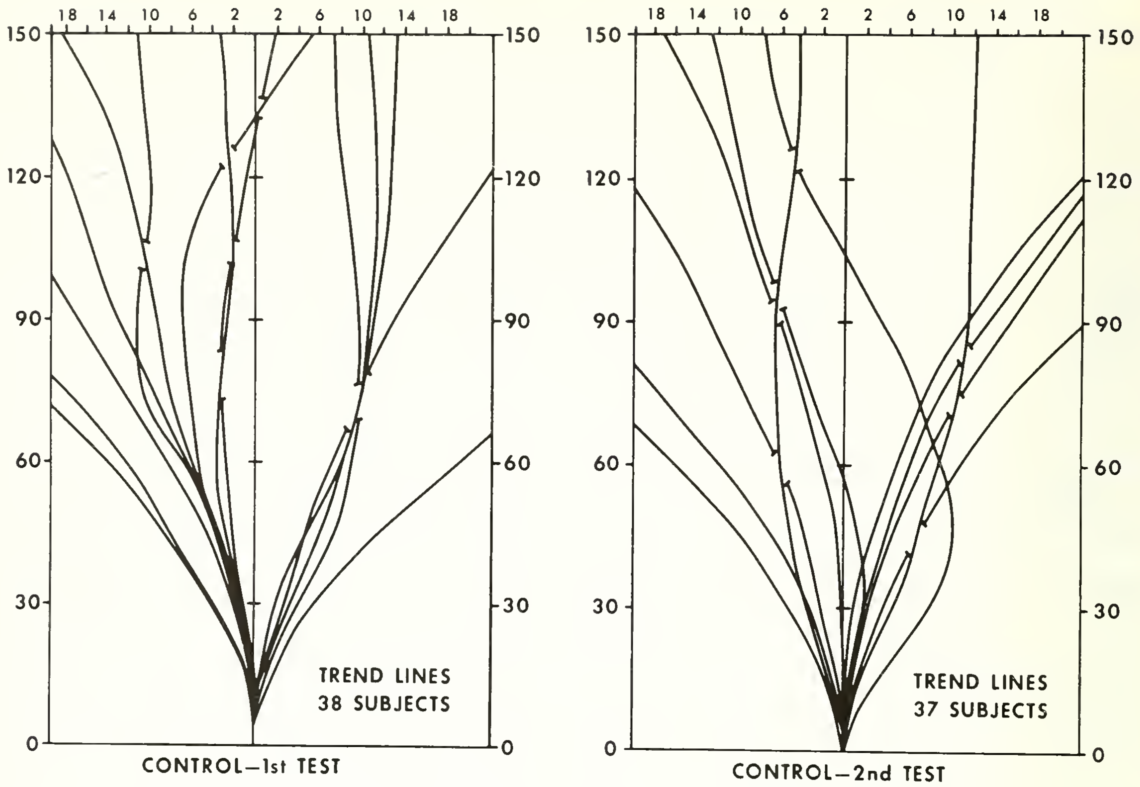
Control Subjects (37). Fourteen of the subjects demonstrated slight increases in measured lateral asymmetry. Twenty-three made no change. Progression of lateral asymmetries has been reported to take place during the growing years[7] and may be accountable for this finding.

On the second test: 7 (18.9 percent) of the subjects showed some improvement in their straight-line tracking, 21 (56.7 percent) decreased in their tracking ability, and 9 (24.3 percent) showed little change.



Figures 2 and 3. Experimental Subjects (39), First and Second Tracking Tests

Number Traveling Total Distance		Mean Deviation from Center Line at 150 ft.	Number Not Completing Course	Mean Distance Traveled Subjects Not Completing
1st test	15	9.92 ft.	24	76.50 ft.
2nd test	26	9.45 ft.	13	100.71 ft.



Figures 4 and 5. Control Subjects (37), First and Second Tracking Tests

Number Traveling Total Distance		Mean Deviation from Center Line at 150 ft.	Number Not Completing Course	Mean Distance Traveled Subjects Not Completing
1st test	23	8.47 ft.	14	97.5 ft.
2nd test	13	10.91 ft.	24	99.0 ft.

DISCUSSION

The data gathered from this two-year study strongly indicates that lateral-pelvic balancing, with the use of the heel-lift procedure, has the capacity of increasing the potential for straight-line tracking for blind subjects. The basic hypothesis that the veering to the short-leg side (low posterior-iliac spine) was not fully supported as only 34 (44.8 percent) of the 76 subjects deviated to the short-leg side on the 1st test; 42 (55.2 percent) deviated to the long-leg side. It is possible that the tonic neck reflex, as influenced by the torque of the spine caused by the lateral deviation, is an influential factor in this phenomenon.[10] Further investigation in this area would be worthwhile.

Due to the mass of data accumulated during the two years of the study, the problem of following each individual's course on the 1st and 2nd tests for both the Experimental and Control groups, is rather difficult but such charts were compiled and are available. To enable a more comprehensive and easier viewing of the patterns of movement, trend charts were prepared by grouping of tracking patterns. These lines are representative of the group actions for both of the tests; Figures 2 and 3 and Figures 4 and 5.

The data compiled strongly supports the hypothesis that lateral postural correction, maintained over a period of time is capable of producing a dual effect. On younger children a high percentage of postural correction can take place, and secondly efficiency can be improved for blind subjects.

It is recommended that the use of the heel-lift technique be expanded for use by those working with blind students throughout the country. It is further suggested that those who become involved, study and record the results of their findings for future comparison with this original data.

The research team wishes to extend their acknowledgement to Mr. Robert Hanson, Superintendent and Mr. Robert Young, Principal, of the Texas School for the Blind in Austin for promoting and supporting the study. Appreciation is also extended to the office force and house mothers for their efforts to help make the study a success.

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NEW DIMENSIONS IN SOUND FOR BLIND YOUTH

John Altmann*
and
Philip H. Hatlen**

INTRODUCTION

Beginning in May 1, 1969, a study entitled *Development of a Sound Laboratory for Use by Blind Children* has been conducted by the Department of Special Education at San Francisco State College. The project was funded by two private agencies through the Frederic Burk Foundation for Education, and was officially concluded on May 31, 1970.

PROJECT CONDUCT

The first months of work were devoted to the procurement of equipment and the construction of a sound laboratory. Much of this work was done by the principal investigator; the selection of suitable and compatible audio equipment proceeded under his direction. The sound laboratory is the equivalent of a fully equipped semiprofessional recording studio. It is a facility in which musicians might record, or abstract sound events might be created and preserved on tape. Tape recorders currently available to the project include two- and four-track stereo, and quadraphonic recorders. Portable equipment is also available.

There are two rooms in the sound laboratory. The listening room is a 15 by 20 foot, fully carpeted, and acoustically treated room with no furniture other than four carefully located speakers. A second room houses recording and amplifying equipment, plus a patch board, microphone mixers, line mixers, a phonograph, preamplifiers, and a monitor-speaker system. Careful thought has resulted in a facility designed as an environment in which to present sound to blind people.

The listening room is a comfortable, relaxing area with no structural limitations to body position or movement. Sound can be received in any location in the listening room with equal effectiveness. The equipment room is also available for blind young people, should they wish to examine and experiment with the equipment. Control panels have been selected which can be easily operated by a blind person. Location of the equipment is situated for ease of operation by blind people.

When the facility was ready and operational, three groups of blind young people were involved. In September 1969, a small group of blind undergraduate college students from San Francisco State College were introduced to the sound laboratory. These college students were requested to evaluate the laboratory in terms of its effectiveness in presenting environmental-free, creative sound-stimuli to blind children. Three students were selected by the project director and principal investigator because of their particular interest in sound and their expertise in evaluating its quality. Two of the three are accomplished professional musicians, and provided many concrete suggestions for bettering the quality of sound in the

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listening room. The third blind student is a graduate psychology major, and is particularly interested in the creative reactions of blind young people to this auditory experience. The three students provided much more than suggestions and evaluation; they became the first users of the sound laboratory. They responded to sound stimuli in exciting and creative ways. They also demonstrated that extremely capable blind young people do not need to learn how to express themselves creatively, they simply need the opportunity. (Although the three students represented a small and very selective sample, it is felt that their responses warrant this generalization.)

Further groups of younger blind students have been involved with the sound laboratory since October 1969. Five students are enrolled in the resource program for the blind at Berkeley High School. Five more students come from the junior and senior high school programs of San Francisco Unified School District. These two groups have alternated in their attendance at the sound laboratory. In the first several months, participation in the sound laboratory was intermittent because it was difficult to pull students out of scheduled educational programs during the week. Beginning in January 1970, however, it was possible to set up a schedule in which each of the two groups attends the sound laboratory at least once a week, and the schedule in no way interferes with the students' attendance in junior and senior high school classes.

The original goals of the sound laboratory were:

1. To use sound and sound equipment to provide both a stimulus for creative expression and an outlet medium for creative expression
2. To use sound as an aid in mobility training.

It is felt by both the participants and observers that a degree of success well beyond the original goals has been achieved, particularly in the first category.

PROCEDURE

The first few visits for each group concentrated on orientation to the facility and to its purposes. This was done in as casual and informal a manner as possible; the stress always on creating a relaxed, nonstructured environment for the students. On occasion, favorite records of the students were played to aid the creation of this relaxed atmosphere. Several tapes were prepared that cannot be related to anything in the repertoire of everyday experiences of the blind person (it is the intent of the project to present sound which has no practical connotation to blind students). In this way we hypothesized that sound could be presented to arouse purely creative responses.

The young people involved in the project were asked to react to this type of sound, after several exposures to it, in one of several ways. Initially, they were asked to react verbally. In this case each person was provided a cassette tape recorder with which they made comments during or following the sound event presented to them, describing as best they could the reactions they had or their attempts to put into words the feelings they had while the sound event was presented. (See Appendix A.)

On subsequent occasions students were provided plasticine clay during the sound event and were asked to create what they wished with the clay, using the sound as a stimulus. They were also given an opportunity to create movement in the laboratory. The latter attempts were occasionally recorded on video tape equipment provided by San Francisco State College. These creative results were encouraging in terms of our original goal.

Although partial success was achieved with these means of expression and response, they all had drawbacks. Our optimum method of working with blind young people in a situation encouraging creativity, and the one on which we base our conclusions regarding its success were as follows.

Subjects were given microphones and asked to talk or make sounds into them. The signals from the microphones were fed into a tape recorder in which various manipulative techniques could be exercised, such as: tape delay, "ping-pong" tape delay, phase shifting, gain increase and decrease, and apparent source changes. The signals were then fed back into one pair of speakers in the listening room. Later on, music and sound of an ambiguous meaning content was presented through the second pair of speakers in the listening room enhancing the creation of mood. This procedure allowed self-generated stimuli and immediate feedback to the participants--and also a simple means of recording the subjects' creative behavior in an unobtrusive manner.

Once the optimum environmental arrangement was fixed and the appropriate means of expression provided, students responded actively, creatively, and enthusiastically, in dance, song composition, poetry, extemporaneous dramatics, singing, and in body movement. We have retained both audio and visual records of these events at the lab.

We feel there is much yet to be discovered. The creative expression of participants has been largely spontaneous and free form in nature with the exception of the expression of the older college-age students. Spontaneity has been encouraged by the project personnel because of its obvious intrinsic value to the students and because of their boundless enthusiasm for it. The sound lab provides in this way a valve for release of normal frustrations of the adolescent and the particular frustrations peculiar to the blind. It also encourages individual growth and the expression of the individual's joy in participation in a creative process. In our enthusiasm for, and success in heightening the motivation of students to be creative, mobility training was not emphasized. But we have come to the following conclusions regarding it from discussions with the student participants and a number of mobility instructors. Simulation of actually encountered mobility situations can be and have been realized in the laboratory, but most specialists agree that it is still preferable to train in actual locations. There are exceptions, however, such as those in which there is potential danger or those which occur but rarely. An example might be that in which a car skids on wet pavement toward a pedestrian cross walk. The sound clues here are subtle. It is possible to identify and record such sounds and to integrate their use into a mobility training program.

Some additional uses for the project's facility have come to light. Blind musicians at high school and college level have requested permission to use the laboratory as a recording studio. This capability offers an opportunity for experience for blind students of music that is not often provided.

CONTINUING NEED FOR THE PROJECT

As one might infer from the above discussion, much remains to be done experimentally and in the area of data collecting on creative responses to sound stimulation. We also intend to explore mobility-training-oriented sound stimulation. In the domain of creative expression we intend to pursue the following areas:

1. Extemporaneous creative expression, emphasizing the widening of the participants' scope of engagement with new and untried mediums of expression, and with new instructional methods.

2. Further exploration of cognitive and individually creative expression.

3. To widen the variety of types of participants in the sound event experience; i.e. more severely handicapped and younger blind students.

4. A more intense study and observation of the feelings elicited by the unstructured sound environment. A liaison with the Langley Porter Psychiatric Clinic through the Sunset Community Mental Health Service has been established; the authors have been offered

open consultation with psychiatrists and psychologists to guide students toward a smoother integration into society, and/or to direct them to competent professional mental health care.

5. To introduce regular opportunities for creative expression and development into the daily curriculum of at least secondary school students, possibly all blind students. Our data on successful methods of working with such students, the requisite sound equipment, and statistical data on the creative growth of participating students is being readied for dissemination to special education teachers, to conferences, and to seminars, and published in appropriate periodicals and journals.

One unanticipated benefit of the project has been to coalesce the interests of disparate faculty members, disparate departmental faculty interests, in the learning and creative expression of blind people. We have actively sought to exploit this shared interest with members of the Art, Radio Broadcasting, and Special Education Departments of San Francisco State College. We anticipate interesting and useful consequences of these encounters.

APPENDIX

Student Reactions to Sound Laboratory

I

"I forgot most of the feelings that I felt when I was there. On one part of the thing I felt like I was sitting on top of an orange. At first the orange is all together. But as time goes on, the orange splits into sections, but the peelings are still on it, so it just gets bigger. Then the orange split into sections so much that it just became nothing. Then at another part of the thing I felt a spring being on the floor and making the whole room go up and down. Then it went around. After that the spring had me going around but getting higher and higher. Then I remembered the song *I Wanna Take You Higher* by Sly. Oh yes, then I remember having a piece of paper shaped into a circle and a string around the paper. The string was holding the paper in such a way as to make it stay circular, like holding on to it real tight. It made me feel like holding on to someone, real tight. Then I thought of the beach and the sand and the water, and all the beautiful things that can happen at a beach. Like a person sitting on the sand and listening to the water go by. Then I remember holding in my hand a plastic bag filled with ice, and the ice was melting, and finally it all melted and I could squeeze the bag and the water would move around inside. So that I could make all the water go out of one part of the bag and make the other part of the bag real fat. Then I felt like I would reach out with all of myself and touch something, I don't know what, maybe a person, maybe something else, I don't know. At that time it felt like everything was cool and I just loved everything in the world. Well, that is most of the thing I felt."

II

"I don't think I can remember what I said on the tape when I heard the recordings on the sound system. The tone quality on those big speakers was beautiful. I felt as though I was at a live rock concert and there were people singing right close to me and the music was coming from all four directions. The electronic music was good but I had to listen very carefully so I could express some feelings and say something on the tape as to how and what I could feel inside. Sometimes I could feel different objects falling upon me or going through my head, metal objects shaking, falling on my head or on the floor. I felt springs shaking and falling upon me and metal bars hitting me. On another tape I felt as though someone was tying me up in eight feet of wire or a metal tape measure so I was completely stranded so tight I couldn't move anywhere. Other times I felt as though I was outside on a sunny spring day and birds were singing and flying in all directions. It made me feel like smiling then. I think I imagined I was here at school in my English class or the Resource Room and those steel bars and spring were shaking and falling on me and going under my desk or on the floor there. That's probably what I said on the tape after I was listening and thinking for a few seconds."

A TECHNIQUE FOR DEVELOPING PERCEPTUAL MATERIALS FOR THE BLIND

Bruce Packard*

Historically, research on the perceptual functioning of the congenitally totally blind has placed much importance on the concept of "visual imagery" for overcoming embedding contexts in field-dependency relationships (Epstein and Park, 1963; Ewart and Carp, 1963; Fieandt, 1958; Foulke, 1962; Hill and Bliss, 1968; Jaffe, 1956; Lobb, 1965; Mace, 1950; Schlaegel, 1953; Sylvester, 1913; Witkin, 1950; Witkin, Birnbaum, Salvatore, Lehr, and Herman, 1968; Worchel, 1951). Recent research on scanning mechanisms in visual perception (Norton and Stark, 1971) has questioned the visual imagery concept by suggesting that visual perception, as in other perceptual modalities, is serial. The results of this research suggest that the congenitally totally blind may not be qualitatively excluded from dealing with complex perceptual relationships in the area which Witkin, et al. (1968) describe as the global-articulated cognitive dimension.

In a recent study (Packard, 1970) a group of congenitally totally blind children maintained superiority over blindfolded normally sighted controls in tactual-kinesthetic problems involving simple form recognition and recognition of geometric forms in embedding contexts.

These kind of results strongly suggest that the cognitive functioning of congenitally totally blind children may be enhanced through the development of materials designed to foster perceptual growth in dealing with field-dependency relationships.

The limited number of available tactual-kinesthetic perceptual training materials has been discussed by Crandell, Hammill, Witowski, and Barkovitch (1968). Commercial development of tactual-kinesthetic perceptual materials for the blind has been viewed as economically prohibitive when research and production costs are evaluated in terms of the limited marketability potential for such a small segment of the population. The probable continuation of commercial scarcity of tactual-kinesthetic perceptual materials has led to the following suggestions for an approach which was used in the Packard (1970) study which employed the adaptation of commercially-printed perceptual materials to a raised line Thermoform format.

It is hoped that this technique will encourage others to tap the rich fund of printed learning disabilities materials now available. A second objective for using print-to-raised-line adaptations of commercially prepared materials is to enable workers with the blind to make greater use of the large body of research on perceptually-handicapped sighted children.

In the Packard (1970) study, tactual-kinesthetic perceptual tasks were translated from selected pages of the *Marianne Frostig Program for the Development of Visual Perception* (Frostig, 1964). The Frostig (1964) rationale for the division of the worksheets into five basic perceptual areas was not followed in view of several studies (Cawley, Goodstein, Burrows, 1968; Mann, 1969; Mann and Phillips, 1967a, 1967b; Olson, 1968) which have suggested little support for her rationale. Support for the potential value of the Frostig materials was provided, however, in

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reviews by Anderson (1965) and Austin (1965). In the Packard (1970) study, worksheet selection was based on whether a worksheet was judged to have a requirement for overcoming embeddedness or a requirement for mere recognition of nonembedded forms.

The method of raised-line worksheet construction was relatively simple and may be adapted to any of the popular perceptual worksheet kinds of materials now available.

Each printed sheet to be produced as a raised-line task is placed face up over a sheet of carbon paper. The inked face of the carbon paper is placed next to the blank side of the printed sheet and secured with paper clips.

Next the printed figures are carefully traced with a pencil. This results in a mirror (negative) image of the original printed sheet on its nonprinted side.

Next a sheet of ordinary aluminum tooling foil is placed over a thin rubber mat. The printed sheet is separated from the carbon paper and paper-clipped to the tooling foil, carbon image side up.

Using a medium ball-point pen, the carbon image is carefully traced. With medium pen pressure the carbon figure is transferred to the foil in the form of depressed lines. This results in a raised-line positive reproduction of the original printed material.

Accurate and consistent reproduction is greatly enhanced by using several varieties of drafting templates which approximate the printed geometric configurations. Templates for almost any size and shape are available in most stationery stores.

In the final step of worksheet production, the foil master is placed on the vacuum grid of a Thermoform Brailon Duplicator and reproduced on a plastic sheet of Brailon paper. The Brailon sheet melts just enough to receive the exact embossed foil image and hardens quickly to a durable, easy-to-handle reproduction. Unlimited numbers of Brailon copies can be made from the foil masters.

In summary, there is a need for pedagogical approaches to the blind which encourage the development of internal self-contained systems of perceptual functioning. It is in this area that the proliferation of learning disabilities research becomes relevant to workers with the blind. It is suggested that educational approaches with the blind may be rendered more effective through the development of basic perceptual skills as a means of encouraging complex perceptual functioning. If blind children are provided with greater varieties of tactual-kinesthetic learning experiences, which become systematically more complex, the traditional view of a qualitative inferiority of the blind in dealing with such relationships may lose some of its significance.

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TECHNICAL AND PRACTICAL UTILIZATION OF ELECTRONIC MOBILITY AIDS FOR THE BLIND*

Michael Brambring

In looking at problem areas in mobility of the blind, several technical aids were reviewed in respect to their principles of operation as well as their actual use. A technical and functional description was then given of two devices which have been studied in detail; the Kay Sonic Aid and the Laser Cane.

Systematic field tests involving two such units were conducted on 24 blind subjects aged 14 to 22 years. For purposes of the experiments, three appropriately matched groups of eight subjects each were assigned to the Kay training procedure, the Laser procedure, and an untrained control condition, respectively. The two experimental groups received 20 hours of individualized instruction. Locomotor proficiency was recorded on film for subsequent analysis and sampled at three stages of training. Three levels of task difficulty were defined by appropriately selected segments from a test course whose design was based upon the realistic demand situations offered by a small town or suburban area.

Observations and statistical analyses lead to a number of conclusions:

1. Locomotor proficiency of blind subjects was subject to substantial influence by training factors.

2. The extent of training also determined the level of success actually attained in operating the various technical aids or guidance systems.

3. No positive effects were demonstrated for the Kay Sonic Aid tested in this experiment, at least given the extent of training possible under these circumstances.

4. Given comparable levels of training, the Laser Cane was found to lead to objective as well as subjective improvements of performance.

5. However, in turn, the improvements noted for the Laser Cane appeared to depend essentially on training effects as such, rather than on the associated electronic system.

6. Under the circumstances noted, the correct procedure would seem to lie in extensive mobility training which would optimally exploit the natural capabilities of the blind persons.

7. Further attempts in the design of technical aids for the blind are clearly indicated. However, their design should more adequately incorporate human factor principles and take into account man's known psychological characteristics. Furthermore, it is recommended that the utilization of such guidance devices in the field be combined with systematic mobility training.

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Editors note: The following is a news release from Richard F. Koch of 67 Smith Street, Lynbrook, New York, 11563.

The AmBiChron:*
AN ELECTRONIC SPEECH COMPRESSOR

The AmBiChron is an electronic speech compressor and expander, a device which speeds up or slows down any recorded speech without pitch distortion. Because it is electronic, it is superior to any compressor on the market. Existing compressors are complex mechanical devices of high initial cost, and they are difficult to maintain. The AmBiChron is inherently much less expensive than the mechanical units, and practically maintenance free.

Speech compression has a wide variety of applications. Among the most important is education for all persons, and in addition, entertainment for the blind and the physically handicapped. The use of recorded educational material is becoming more and more widespread, both for group and individual instruction and advancement. In schools it adds a new dimension to the traditional lecture. For the individual it offers a means for keeping abreast of new advances in one's own profession, for opening new vistas in foreign languages, etc. For everyone, particularly the blind and the visually handicapped, it offers entertainment without reading by eye. These applications of recorded speech already exist in talking books for the blind which have been available for many years. In visual reading, the speed is set by the individual reader in accordance with his own preferences, abilities, and understanding of the topic being read. In listening to a recording the rate is set by the person making the recording. Blind users of talking books have often speeded up their records, and accepted the accompanying "Mickey Mouse" pitch distortion. It is likened to playing a 33-1/3 rpm record at 45 rpm, or worse. Most users are unwilling to do this, and no one really likes it. Other important applications are found in radio, TV, and in military problems.

The AmBiChron offers a means for speeding up (or slowing down) recorded speech, without distortion. Although this could be accomplished at high cost in the past, it can now be done by a simple electronic apparatus that brings this capability within the range of schools, professional individuals, the handicapped, and others. Much interest has already been shown in the AmBiChron by professional workers with the handicapped, by audiovisual specialists in the teaching profession, and by military training experts.

Substantial time and money has been spent on the development of the AmBiChron, and a finished working model is ready to be packaged for the mass market. The model uses only off-the-shelf components, readily available from suppliers of quality electronic parts. A patent application is on file with the U.S. Patent Office, and is expected to result in a strong patent.

The writer seeks venture capital for manufacturing and marketing of the AmBiChron, or will negotiate any other business arrangement beneficial to both parties. The writer is sole owner of all rights in the AmBiChron, and offers his considerable insight into potential markets as well as his engineering know-how.

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*Trade Mark.

A STUDY OF THE TACTUAL DISCRIMINATION TEST FOR MEASURING TACTUAL ABILITY OF THE VISUALLY HANDICAPPED

Gordon D. Clegg*

Tactual ability can often dictate the success or failure of a blind individual's attempt to learn braille. To reduce some of the frustration of failure, there is a need for an evaluative tool used as a screening device for tactile problems.

An evaluative tool, the Tactual Discrimination Test (TDT), was devised at the Murray B. Allen Center for the Blind, Salt Lake City, Utah, to help identify clients with tactile problems.

It was hypothesized that the level of performance on the TDT would be positively and significantly related to an ability to discriminate among braille characters.

The population in this study (N:52) was comprised solely of "legally blind" participants who had completed a formal course in braille reading. These were people of both sexes who were teachers, staff, and clients of the Murray B. Allen Center for the Blind.

The TDT is a sorting test which consists of 56 pieces of sandpaper of various sized grits and a sorting box into which the pieces of sandpaper are placed. There are 14 pieces each of extra-fine, fine, coarse, and extra-coarse sandpaper. Each piece (1-1/2" x 2-1/2") was laminated to a stiff piece of cardboard of like dimensions to give stability. The size of the pieces of sandpaper was selected arbitrarily.

The box (22" x 22" x 2") is sectioned off into four small bins and one large bin. The large bin (12" x 22" x 2") is positioned closest to the subject. The four small bins (5" x 9" x 2") are behind the large bin. The back is raised 30 degrees and the apparatus is placed on a surface to be as high as the subject's waist.

Also used were a sight occluder and a timer.

When the subject began the test, a timer was set. The subject then sorted the various grades of sandpaper. When the test was completed, the time and the number of correct responses were recorded on a specially prepared data sheet.

Each subject's ability to discriminate among braille characters was ranked and judged by two actively employed certified braille instructors who were familiar with the braille skills of each of the subjects. At no time prior to the braille ranking were the teachers informed of a particular subject's scores on the TDT.

Two correlation coefficients were computed: one for the length of time to complete the TDT vs. the braille rankings; another for the number of correct responses on the TDT vs. braille rankings. The results are given in Tables 1 and 2.

The correlations between time and test scores of the TDT and braille ranks appeared to be significant at the one percent level. It is felt that with more development this test has the possibility of becoming a valuable tool in analyzing a client's tactual potential for braille.

Braille teachers may also find this tool useful as a screening device to group students into classes with like tactual ability.

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TABLE 1

Correlations Between Braille Ranks and Time to Complete TDT and Between Braille Ranks and Correct Responses on TDT

N:52

Variables	r_{xy} obtained	Significance
Braille Ranks and Time to Complete TDT	.62	.01
Braille Ranks and Correct Responses on TDT	.55	.01

TABLE 2

Means and Standard Deviations

N:52

Variables	Mean	Standard Deviation
Braille Ranks and Time to Complete TDT	7.17	3.56
Braille Ranks and Correct Responses on TDT	49.37	5.33

This test may have some usefulness also in indicating the rate of loss in the sense of touch for those diabetics with neuropathy.

NEUROTICISM IN BLIND CHILDREN, ADOLESCENTS, AND YOUNG ADULTS

Evangelos C. Dimitriou*

It is a common belief that blind people show neurotic symptomatology more frequently than normal or other handicapped people.

Many explanations have been proposed to support this belief. The most popular is that maladjusted behavior in blind children and adolescents stems mainly from external factors such as home environment, institutionalization, the reaction of sighted people toward the blind, and the like (Sommers, 1944; Norris, Spaulding and Brodie, 1957; Freedman, 1967).

We had the opportunity to examine clinically all the students of the School for the Blind of Thessaloniki (Greece). This school operates on a residential basis, offering both full educational and rehabilitation facilities.

One hundred students were examined--59 males (mean age 17.3 years) and 41 females (mean age 19 years). Many of them displayed neurotic characteristics.

Twenty seven students (11 males and 16 females) had developed a full neurotic clinical picture, showing excessive anxiety, palpitations, sweating of hands, tremor, insomnia, headaches, etc., and were classified as neurotics. The youngest of these 27 students was 9 years old and the oldest, 30.

Nineteen out of the 27 (or 70.3 percent) neurotics (Group A) came from a disturbed home environment, whereas only 20 out of the 73 (or 27.4 percent) who showed no neurotic symptomatology (Group B) came from a similar environment.

The mean stay in the school was 9.5 years for Group A vs. 5.8 years for Group B. The mean stay for the whole population at the school was 6.8 years. If we exclude those students who were below 9 and above 30 years of age (12 of them) the mean stay for Group B rises to 6.1 years.

Females showed twice the neuroticism of males--39 percent and 18.6 percent, respectively.

We could not find any distinctive relationships between the cause or degree of blindness and neuroticism.

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Name: Auditory Beacon

Source: Mr. James C. Swail
Radio and Electrical Engineering Division
National Research Council
Ottawa 2, Ontario, Canada

Availability: Experimental prototype

Small box-shaped device emits a beep every 10 seconds. Allows easy return to object or location on which it has been placed.

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Name: Data Flow Optical Page Reader (DFR-100) (Revised listing)

Source: Datatype Corporation
1050 West 163rd Drive
Miami, Florida 33169

Availability: From above

Price: $9,450

The Reader operates exclusively with input prepared on special typewriter (Datatype Corporation). It reads not the regular inkprint but the bar code underneath each letter which the typewriter provides.

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Name: Demonstration Tape "Choosing The Appropriate Compression"

Source: Center for Rate-Controlled Recordings
University of Louisville
Louisville, Kentucky 40208

Availability: From above

Price: $3.00

A listening selection, "Reading by Listening to Time-Compressed Speech," by Emerson Foulke, has been divided into six segments. The word rate in the first segment is 210 wpm. In each succeeding segment, the word rate is increased by 35 wpm until, in the final segment it is 385 wpm. A multiple-choice test is provided, segmented to match the portions of the tape. By listening to each segment and answering the corresponding questions the level of comprehension at the various word rates can be assessed.

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Name: Electronic Thermometer

Source: Mr. James C. Swail
Radio and Electrical Engineering Division
National Research Council
Ottawa 2, Ontario, Canada

Availability: Experimental prototype

Models of the instrument have been developed with either tactile or auditory readout for use by blind technicians.

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Name: Eye-Kon 10-46 Low-Vision Large-Print Microfilm Reader

Source: Mr. Edward M. Lee, President
Information Handling Services
Denver Technological Center
P.O. Box 1154
Englewood, Colorado 80110

Availability: Pre-production prototype

The system consists of a portable cassette-loaded, self-contained 16mm film reader. Textual information is recorded in a scroll fashion on the film. Manual control knobs advance the film. Large print is projected on a 4" x 6" screen. The film is produced by entering the entire contents of a book into a computer. Material is reformatted according to specifications geared to optimizing the display for the visually handicapped. The information is printed out directly onto the film and duplicated.

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Name: General Auditory-Vibratory Experience Translator (GAVET)

Source: Shirley J. Heinze, Ph.D.
University of Illinois
College of Medicine
Chicago, Illinois

Availability: Experimental prototype

The instrument translates sound into tactually perceptible vibrations. It has been found to enhance vocalization in deaf children when used in conjunction or alternating with a hearing aid. A miniaturized version of the aid has also been designed.

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Name: Linear Tape Measuring Device

Source: Sensory Aids Evaluation and Development Center
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Availability: Laboratory prototype

A 10-foot commercially available tape measure was perforated to fit a sprocket drive paper tractor. The tractor was geared to a counter which was modified into a tactile indicator by adding braille numbers. All components were mounted on a base that also served as a zero reference while using the tape. The tape can be locked at any setting for repeated measurements. A knob is provided to return the tape to the container. The reading accuracies are better than 0.1 inch.

Name: Mowat Sonar Cane

Source: G. C. Mowat
37 Cliff Road
St. Heliers, Auckland 5, New Zealand

Availability: Experimental prototype

All the electronic components are located in the cane itself. It will select and indicate the nearest object within range in the directionin which it is pointed. The signal is a vibration in the handle when an object is located. The frequency of vibrations increases with the nearness of the object.

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Name: Mowat Sonar Sensor

Source: G. C. Mowat
37 Cliff Road
St. Hellers, Auckland 5, New Zealand

Availability: Experimental prototype

The device is self-contained and measures 4-3/4" x 2" x 7/8". It indicates an object within its range by means of vibrations. Distance is indicated by an increase in speed of vibrations as an object comes nearer. The sensor is designed as a secondary aid for long cane or guide dog users.

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Name: Optacon (revised listing)

Source: Dr. James C. Bliss
Bioinformation Systems Group
Engineering Techniques Laboratory
Stanford Research Institute
333 Ravenswood Avenue
Menlo Park, California 94025

Availability: Telesensory Systems, Inc.
4151 Middlefield Road (Suite 101)
Palo Alto, California 94303

Price: $5,000

Direct translation reading machine. Inkprint scanned with a hand held camera is reproduced tactually by an array of vibrators. A training manual is provided with each Optacon and equipment service arrangements are available. In addition to the reading machine itself a visual display and tracking aid, intended for training purposes only, is available. The Visual Display (price $800) by means of 144 lights, replicates visually the tactile pattern which is being presented to the student. The Tracking Aid (price $200), a mechanical system for guiding the camera allows the beginner to concentrate on the tactile display by providing automatic alignment to the line of inkprint.

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Name: "Stabilizer" Helmet

Source: Francis Spelman, Senior Engineer
University of Washington
Regional Primate Center
Seattle, Washington 98105

Availability: Experimental prototype

Lightweight plastic helmet has a gravity-sensitive device connected to vibrators positioned near the ears. When head tilts beyond a certain point the vibrator on the appropriate side emits a clicking signal. The frequency of the clicking corresponds to the degree of tilt and alerts the wearer to return his head to the upright (neutral) position.

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Name: System for Conversion of Print to Speech

Source: A. Surlan and J. Virant
Faculty of Electrotechnique
University of Ljubljana
Yugoslavia

Availability: Experimental prototype

Two versions have been developed. One version produces each letter in spoken form as it is typed on an associated typewriter. The spoken form of the text is produced in real time, but it can be recorded also for future reference. The second version is a reading machine for use with inkprint material. In either case information is sensed from the printed symbol with lenses and a photoelectric mosaic, and processed by logic circuits. (In the experimental matrix Siemens photodiodes type APY 13/2 were used.) The logic circuits produce switching functions which act as input instructions to the speech generator. Voiced letter sounds are recorded optically on celluloid tape, read photoelectrically, and amplified.

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Name: System for Production of Braille from Punched Tapes

Source: T.N.O.
Delft, Holland

Availability: "One-off" working model at De Nederlandsche Blindenbibliotheek
Nordwal 7, The Haue, Holland

An eight-hole punched tape is produced on a Friden programmable Flexowriter. The completed tape is fed into the reader of the code translator. There it is scanned and the information transformed into commands which are given to the braille printing machine. The latter consists of a modified Perkins brailler and automatic cutting apparatus. A code-translator has a maximum capacity of one braille plate embossing and six braille printing machines. The speed of production is four characters-per-second. Since the system can only use 8-hole tape, and those normally used by the printing industry are either 6- or 15-hole tapes, recoding is necessary before commercial tapes can be used. This is now done with a Digital PDP-8 computer.

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Name: Ultrasonic Obstacle Detector

Source: Mr. James C. Swail
Radio and Electrical Engineering Division
National Research Council
Ottawa 2, Ontario, Canada

Availability: Experimental prototype

The device has a tactile output and is powered by built-in rechargeable batteries. It generates 40 kHz, transmitted as two-millisecond pulses in a narrow beam at a pulse repetition rate of 10 per second. The receiver unit is turned on immediately after the termination of the pulse. A range switch selects the length of time the receiver remains on after each pulse. Ranges for response to targets are set at 4, 7, and 15 feet. A reflected pulse received within the selected range fires a monostable circuit. This drives a solenoid-operated tactile stimulator, a rod which vibrates in the handle of the unit, against the operator's forefinger.

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Name: Variable Speech Control

Source: Cambridge Research and Development Group
Bridge Street
Westport, Connecticut 06880

Availability: Production prototype

A solid-state module about one cubic inch in size, installed in a phonograph or tape recorder, permits playback to be controlled so that normal speech can be varied from 90 to 500 words-per-minute without alteration of pitch.

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